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THE TREATMENT OF SELECTED CASES OF CHRONIC CATARRHAL DEAFNESS BY X-RAYS[1]

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A REFERENCE to the treatment of catarrhal deafness and head noises by x-rays occurs as early as 1904 in a paper by Joseph Beck (1), of Chicago. The patient was a woman of 51 who, after four months of conservative treatment for what her physician diagnosed as a chronic catarrhal condition of the middle ear, was submitted to an ossiculectomy. Only partial relief of the ear noises followed. She was then given x-ray treatment to the ears for about three weeks without the slightest relief, whereupon radium was applied directly to the tympanic cavity every day for about six weeks with equally poor results. No mention was made of the x-ray factors.

In 1906 Dionisio (2) reported 20 cases treated by x-rays, the patients suffering from chronic suppurative inflammation of the middle ear. Sixteen of these cases were cured, he states. The hearing of many of them also improved.

From that time on many papers appeared in the literature describing the effect produced by x-rays or radium on impaired hearing and tinnitus. Desjardins (3) reviewed critically some fifty which appeared up to 1930 and concluded that irradiation may influence tinnitus especially and sometimes also exert a favorable action on hearing. The crudity with which some of the treatments was often conducted must, he believed, undoubtedly account for a certain proportion of the failures.

The cases here recorded were all examined by a single otologist and the diagnoses made of chronic catarrhal or secretory deafness. No case of chronic suppurative middle ear disease or otosclerosis was treated knowingly. Each case was referred only after all the customary otological-therapeutic procedures had been practised without avail. Each patient had the commonly accepted hearing tests of whispered and spoken voice, tuning forks, and a modified Rinne before and after the x-ray treatment series.

The same x-ray formula was used in the entire series and the physical set-up was checked at frequent intervals to keep the radiation identical as far as could be.

From 1929 to 1935, inclusive, 140 patients were treated. Of this group, 73 were improved as to hearing and tinnitus; 65 were unchanged, and two were made worse. In the unchanged group are included 14 cases on which there was no adequate follow-up.

Of the improved group, 67 had nine treatments to each ear and six received only eight treatments. Since all of these patients showed improvement and only four cases of the total group who received less than nine treatments showed improve-

[1] Presented before the Radiological Society of North America at the Twenty-second Annual Meeting at Cincinnati, Nov. 30–Dec. 4, 1936.

ment, I have designated nine treatments as the acceptable course or cycle.

There were 20 patients of the 51 followed and classified as unimproved who had nine treatments each. The remainder had as few as two treatments and none more than six.

There were 20 cases of the 140 who had tinnitus. Eighteen of these were in the improved group: the other two are the only ones of the entire series that had nine treatments who were reported by the otologist as having been made worse by x-radiation.

Accepting a cycle of nine treatments as the optimum, approximately 78 per cent who received it were benefited. No patient has been followed less than a year, the majority for more than three years, and some as long as five years.

The audiometer was not used because at the beginning of this work one was not available. It has rightly been said: "The ability to hear the human voice is, after all, the most essential criterion of the hearing ability." A psychic element, I believe, can be ruled out as playing any major part in the improvement in a group as large as this that has been checked by a competent aurist and followed as long. A comparable rise in voice test from 1/20 W 1/20 to 20/20 W 20/20 from 1 ft. V 1 ft. to 20 ft. V 30 ft., following x-ray therapy in a substantial group of cases should not be charged to accident or psyche.

There were six patients treated in the age group one to ten; 15 in the age group ten to twenty; 52 in the age group twenty to thirty; 33 in the age group thirty to forty; 21 in the age group forty to fifty, and 13 in the group over fifty years of age. The youngest was aged two and one-half, the oldest sixty-nine years; about equally divided among males and females.

The much abused tonsil did not seem to play a direct part in the beneficial outcome of x-radiation of these cases. Forty-eight of the improved group of 73 had had tonsillectomy from one to twelve years before x-irradiation. Of the 20 patients in the unimproved group who had the optimum cycle of x-ray treatments, 14 had had tonsillectomy.

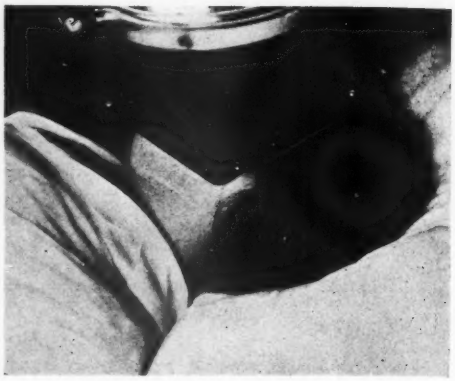

Fig. 1.

The x-ray factors employed were as follows: 145 kv.; 5 ma.; 0.25 mm. Cu and 1 mm. Al filter; 50 cm. distance; 15 × 15 cm. field, 5 minutes' duration; about 90 r in air to each ear-field at one sitting and repeated at weekly intervals for nine treatments. A large field with the hypotenuse of the two right-angles extending from nares to mastoid tip (Fig. 1) was chosen deliberately to include the nasopharynx, the course of the eustachian tube, the mastoid and ear structures, because of the accepted relationship of lymph adenoid tissue and infection to chronic catarrhal deafness and, at the same time, to include the origin and distribution of the eighth nerve and its communications in the temporal bone for possible neural stimulation.

How x-ray therapy brings about improvement in cases of chronic catarrhal deafness may always remain in the realm of controversy. As a matter of clinical experience, I do not think it is necessary to go to the extreme of discussing the improvement as seen in these cases, as did Stokes (4), on the basis of the electrical theory of matter. He believed that electronic equilibrium was the governing factor in metabolism and that deafness could be cured readily by electronizing the pituitary and auditory regions by small "ionizing doses" of roentgen rays. His dosage seemed infinitesimal. McCoy (5), who followed his method and reported a mixed group of

deafness cases, states: "Whether there is penetration to the pituitary gland is a question, but that some change takes place in it is given food for thought by the alteration in blood pressure." This statement was based on two cases.

Jarvis (6), in reporting his series of cases, seemed much more rational. He found that the type of patient subject to frequent head colds with more or less constant catarrhal discharge of the throat and frequent intervals of stuffiness in the ear, with an accompanying impairment of hearing, responded best to the use of roentgen rays. In these individuals he often found the inferior and middle turbinates increased in size, lymphoid nodules present on the posterior pharyngeal wall, and often a prominent band of lymphoid tissue running up either side of the pharynx just posterior to the tonsillar pillar. A study of the lymphoid tissue in the throat following the use of roentgen rays showed that in 48 hours it markedly decreased in size and redness and, with it, the catarrhal discharge from the throat. His dose was so small that he did not believe it could affect the lymphoid tissue but influenced, rather, the bacterial content of the throat.

Lymph adenoid structures are highly radiosensitive and the response of chronic inflammation to x-irradiation now seems well established. Bacteria which *in vitro* will stand enormous doses of radiation, lose their virulency *in vivo*. The softening effect of x-radiation on scar tissue following the operation for breast cancer, which enables the adhesions in the neighborhood of the axilla, the result of the operation, to become stretched, and on scar tissue following burns and keloid formation generally, is commonplace.

If deafness is due to fibrous tissue which may be comparatively small in amount, binding together the ossicles which transmit the vibration of the drums to the auditory apparatus, it is reasonable to believe that the x-rays may likewise affect the inflammatory exudate which gradually becomes adhesive in quality and attaches itself to the ossicles.

On the other hand, nerve tissue stands at the other extreme and is considered radioresistant. The beneficial effect of x-radiation on the sympathetic nervous system, however, has been affirmed repeatedly. The anesthetic effect of roentgen rays on nerve pain is a common experience. Improvement in both sensory and motor phenomena occurs in syringomyelia.

Richardson (7) believes that the neural stimulating dose, as he calls it, has a place in the treatment of deafness, and especially tinnitus. His dosage factors are 50 kv.; 8 ma., 24 in. distance; 1 mm. Al filter; 12 seconds, distributed over the entire head through four portals of entrance. He states that it nearly always quickly relieved the tinnitus aurium; furthermore, he could not discover that the original pathology plays the obviously determining rôle with its effect on the efficiency of the treatment. Improvement in hearing, when it occurs, is either astonishingly immediate or is delayed for some time, becoming apparent only after several treatments; the gain is apparently a progressive series of steps. His records, based on 600 cases, show improvement from a slight degree to a complete cure, in not less than 60 per cent of a mixed group of cases. The fact that the auditory nerve differs from the optic and olfactory nerves in having a peripheral as well as a central origin, Richardson believes may have a bearing on the importance of the neural effect of radiation.

CONCLUSIONS

1. Seventy-three cases of chronic catarrhal deafness of a group of 140 of varying degrees of deafness were improved by roentgen-ray treatment.
2. Eighteen patients with tinnitus in a group of 20 were cured.
3. What is believed to be an optimum cycle based on certain definite x-ray factors is described.
4. Sixty-five cases were unchanged and two were made worse by x-irradiation.
5. No case of nerve deafness or otosclerosis was treated.

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PITUITARY AND ASSOCIATED HORMONE FACTORS IN CRANIAL GROWTH AND DIFFERENTIATION IN THE WHITE RAT: A ROENTGENOLOGICAL STUDY[1]

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IN man, in a large proportion of cases in which the cranial skiagram gives evidence of cranial dysplasia, there is found, clinically, evidence of past or present disturbance of pituitary function either during the growth period, subsequent to it, or throughout life. Such disturbance, whether it be on the side of hyperfunction, hypofunction, or a period of the former followed by a phase of the latter, we shall describe under the general heading "Pituitary Dysfunction." By cranial dysplasia we mean such abnormality in form or structure that the skull can be regarded as "malformed," the degree of this being subject to wide variation, ranging from a proportion and structure which cannot be regarded as outside the zone of supposedly normal variation, to gross deformity. Thus, the skull may be proportionate in its component parts and structure, the abnormality lying in its being too large or too small for the sex and age of the patient; the facial component may be disproportionate to the size of the brain-case through overgrowth or underdevelopment of either the former or latter; the component parts of the face, respiratory and masticatory, may be disproportionate one to the other, from overgrowth or underdevelopment of either. There may be such a calvarial contour as is abnormal for the sex or age or even for the stock to which the individual belongs. The brain-case may be abnormal in thickness or density, or its normal architectural structure, of three tables, may be lost to a lesser or greater degree.

Clinically, from such a correlation between cranial dysplasia and pituitary dysfunction, a causal relationship may be presumed between them; nevertheless, the need is felt of experimental evidence to demonstrate the influence of pituitary hormones on cranial size, form, and structure. For this reason it was decided to examine roentgenologically the crania of rats treated with various relatively highly purified pituitary hormone-fractions.

Against the disadvantage of the fact that the rat cranium has not been the subject of any extensive study by craniologists may be set several distinct advantages; the rat of the Wistar stock is stable morphologically, it is in wide use for experimental purposes, its skull in many ways shows a pattern of growth not unlike the human, and there is a well marked difference to be seen in size and proportions between the male and female crania. But the chief advantage lies in the fact that the same animals, studied radiographically, have been investigated physiologically by a number of workers whose findings are available for confirmation or control of x-ray findings; especially is this true of animals that have been the object of calcium metabolism studies and in which the daily output of calcium, and the balance, is known over relatively long periods.

There are certain advantages in investigating this problem by a roentgenologic method, the chief being that observations and conclusions drawn from it are directly transferable to the clinical field of human radiology. In this latter, craniometry so far is in very slight use in the living patient, whereas cranial skiagraphy is almost a routine procedure and gives, in addition, important information not available to the craniometrist of the living patient, namely, a relatively accurate impression of the thickness of the skull and of its architectural structure.

There are, however, considerable roentgenologic difficulties to be overcome in studying the rat cranium. In size it is

[1] Presented before the Radiological Society of North America at the Twenty-first Annual Meeting, at Detroit, Dec. 2–6, 1935. Received for publication Aug. 4, 1936.

small, even in a fully grown male at the age of one year the cranium measures in total length only about 43 mm., while its height is only about 11.5 mm. (1). Thus in employing the technical equipment used in man it is very difficult to secure structural detail comparable to that seen in the human cranial skiagram. The question of placing the cranium for a true lateral view is also difficult.

Technic.—In the preliminary study only dissected crania were used. The animal is killed, the lower jaw disarticulated, and all soft tissues removed from the snout and brain-case by immediate dissection. If this is begun in front, at the base of the upper incisor teeth, the soft tissues down to the periosteum can be swept upward and backward off the snout and vault, clearing the orbits and zygomatic fossæ simultaneously *en masse;* in the same way the hard palate and the base of the skull can be cleaned. The skull is then sawn longitudinally into two exact halves by means of a thin disc saw on the dental engine. This is first carried one saw thickness to the left of the suture between the nasal bones so that the septum remains intact on the right half-cranium, and, at the level of the frontonasal suture, it is made to cut the serrations of the suture between the two halves of the frontal bone. It travels backward along the sagittal suture, spreading the digitations so that there is no difficulty in keeping the exact midline; the cut ends at the foramen magnum. On the palatal aspect the saw enters between the incisor teeth and divides the hard palate, one saw breadth to the left of the middle line. At the posterior nares it enters the body of the pre-sphenoid exactly in the middle line, divides the ethmoid, pre-sphenoid, basi-sphenoid and basi-occipital bones to the foramen magnum. The brain is removed and the two halves of the skull dehydrated in alcohol for 12 hours and allowed to dry. The two halves of the mandible are separated, cleaned, and similarly treated. Both halves of the cranium and jaw are skiagraphed.

It was found that the modern fast, double-emulsion x-ray film was quite unsuitable for the radiography of the dissected cranium; the grain is relatively coarse and the effect of this is increased by the double emulsion. These facts cause considerable lack of detail-definition in the subsequent enlargement, for these skiagrams can be studied adequately only when enlarged about three to five times. It was ultimately found[2] that a fine grain emulsion, such as is used in miniature cameras, Du Pont "Micropan" or Eastman "Panatomic" negative film, gave excellent results.

This is loaded in thin light-opaque paper cassettes; low kilovoltage (below 40 kv.), 15 ma., with an exposure of about eight seconds became a standard technic. The anode-film distance was 15 inches and a Westinghouse line-focus[3] tube was used. Development was five minutes in Eastman x-ray developer (D-19-B), all processing solutions being held at 18° C. by a thermostat operated by a Black (2) relay. This technic gives an x-ray film of excellent contrast, freedom from grain and fine detail, from which a copy-negative is made on fine-grain film, using a Leica camera critically focussed by means of a sliding focussing copy attachment. The camera is at a constant distance from the illuminator so that the relative sizes of crania are preserved. Exposure is constant and development is for 10 minutes, in fine grain developer (Eastman D-76), at 18° C. Enlargement is on paper or "Translite" film; film–paper distance is constant as are both exposure and development, which are measured in seconds by metronome. Thus, throughout the whole standard process, as nearly as can be achieved, the only variable that occurs is that of density of the individual cranium.

The Penetrometer.—In the skiagram it is essential to get an accurate impression, not only of cranial size and relative proportion of snout to brain-case, but also of

[2] We wish to acknowledge our indebtedness to Mr. W. S. Trotman, of the Eastman Kodak Co., of Canada, for his help in experimenting with a large series of emulsions.

[3] Supplied by the generosity of the Westinghouse X-ray Company, Inc., New York City.

architectural structure and density of the bone at different sites. Although this can be achieved by radiographic and photographic processes being maintained constant, it is desirable in all cases that one should be able to check on such constancy. To permit of this there is placed upon the cassette, with the cranium, a penetrometer of 99.9 per cent pure cast aluminium, which measures 41.25 mm. long by 3.55 mm. wide. The 11 steps range from 0.5 mm. in thickness, by increments of 0.5 mm., to 10 mm., except in the last three steps, in which instance the increment is 2 millimeters. The skiagram of this gives not only a measure of the absolute density, but shows whether or not two given skiagrams are comparable—an essential in comparing the skiagram of a treated animal with its control.

The Rat.—This department colony was started in 1928 from 13 pairs of Wistar rats, and at the time this work was done it numbered about five thousand rats, about one thousand of which had been hypophysectomized. The females are used for breeding at about the tenth week of life, being discarded when they show low fertility or poor condition; the males are mated at about twelve weeks, and continue in use until about eighteen months old, when they usually begin to show such signs of age as harshness and yellowing of the coat. For general laboratory purposes a rat is considered "adult" when about three months old, although sexually the females mature, on the average, anywhere from the forty-fifth to the sixtieth day of life, and cases of maturity have occurred as early as the thirtieth day.

The average litter is about six pups, but 16 has been recorded and the lowest has been two. The young are allowed to suckle for the first month of life, although they begin to eat cage food as early as the twelfth day. The diet was originally a modified McCollum diet; later, "Purina" dog chow only has been given.

On the average 10 litters are born daily, giving a yearly birth roll of about 20,000 rats, which, with a constant population of about 5,000, means a yearly consumption of 15,000 animals. A large part of this represents animals used about the twenty-first day in the assay of "maturity" (pituitary) hormone, A.P.L. and for the Aschheim-Zondek test. Ketogenic hormones are assayed on animals of about forty days of age, while for somatotropic, thyreotropic, and adrenotropic hormones rats slightly older or about 100 gm. of weight (60–90 days) are used, such animals having been hypophysectomized about a month previously. For assay of the last three pituitary hormone-fractions, the hypophysectomized rat is routinely used.

We think it desirable to give the foregoing facts about the colony, since they have an important influence in the growth of the normal animal, and it enables other workers to compare our material with their own. The special needs of this laboratory are the reason why the rats, whose cranial skiagrams appear in the plates, are for the most part "young adult" animals, and there may appear to be a lack of what, elsewhere, may be regarded as, anatomically, fully grown adults. We have found, however, that our growth curve closely parallels those given by Donaldson (3) for the Wistar colony.

Radiographic Expression of the Morphological Changes in the Skull of the Albino Rat during Normal Growth.—Of the 232 rats in which the cranial skiagram has been studied by the above technic, 44 were normal controls, 12 of them being females. They ranged in age from one to 13 months, and were selected by size and weight as representative of the average in the colony at various stages of growth. In the illustrations, only males are shown, since in the rat not only is the male skull larger (1), but also, as in man, as full adult growth is attained, it becomes more markedly differentiated. The nasal bones are longer, muscular attachments are more strongly developed, particularly the supra-orbital ridge and its posterior prolongation from which the temporalis muscle finds origin and which is homologous to the superior curved line of temporalis attachment in

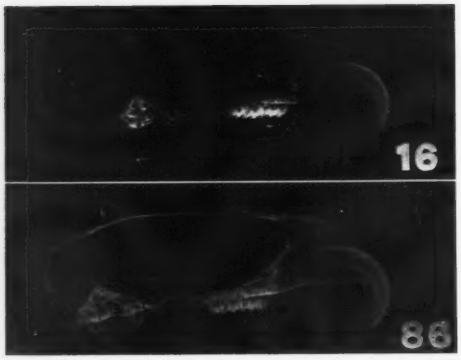


Fig. 1. Normal controls. No. 16, age 31 days; weight 50 gm.; male: No. 86, age 46 days; weight 128 gm.; male.

man; but the chief difference is found in the greater development of the supra-orbital bar which increases the acuteness of the fronto-nasal angle and the more marked development of the frontal sinus homologue behind it.

Comparative Anatomy of the Rat Cranium as Seen in the Skiagram.—Posterior-inferiorly (No. 16 and No. 86, Fig. 1) is seen the tympanic bulla, the three semicircular canals and between those the denser petrous portion of the temporal bone in which can be distinguished the bony canal of the cochlea. Superimposed upon the shadow of the tympanic bulla anteriorly can be seen the synchondrosis between the basi-occipital and the basi-sphenoid bones, which forms the landmark in drilling the basi-sphenoid in the operation of hypophysectomy by Selye's (6) modification of Smith's method, the trephine being placed just anterior to it. There is no sella turcica in the rat, the pituitary gland lying upon the basi-sphenoid about the level where the shadow of the tympanic bulla cuts this bone. More anteriorly is seen the synchondrosis between the basi-sphenoid and pre-sphenoid, at the anterior end of which bone is seen the shadow of the optic foramen. Vertically above the middle of the pre-sphenoid is the broad attachment of the posterior root of the zygoma from which this bone sweeps forward and downward.

In front and above the optic foramen is seen the cribriform plate of the ethmoid, and the inverted U-shaped shadow of the anterior root of the zygoma. Below the former is the alveolar process of the maxilla bearing the three molar teeth, the roots and pulp cavities of which show clearly. The first molar erupts about the nineteenth day, the second about the twenty-first day, while the third erupts about the thirty-fifth day. In No. 16 it is apparent that the third molar is not quite completely formed and is only partially erupted. As Donaldson (3, p. 52) points out, "Owing to the lack of precise data, no exact comparison can be made with the eruption of the corresponding teeth in man. Nevertheless, the incisors and first and second molars in the deciduous dentition of man do erupt at about the equivalent ages (*i.e.*, thirty times the age in the rat) while the relation of the age of eruption of the third molar (the 'wisdom tooth') to that of the second molar is similar in the rat to that found for these teeth in the permanent dentition of man." A wide diastema separates the molars from the incisor teeth, which erupt from eight to ten days after birth, are rootless, and grow throughout life at the average rate of 2.2 mm. per week in the upper, and 2.8 mm. in the lower incisors (Donaldson). The upper incisors are strongly curved and form a large segment of a circle. The anterior surface of the tooth is both thicker and denser in the skiagram than the posterior, due to its being composed of dentin and enamel, while the posterior is dentin and cementum. The tooth is largely hollow and the gradual tapering of its wall to a fine point at the proximal end of the tooth or "root" is characteristic of the normal.

Posterior to the shadow of the semicircular canals is that of the occipital condyle, which is lateral to the foramen magnum. Superior to this is the supra-occipital bone which forms an angle with the interparietal bone.

The calvaria is of much importance in this study and the characteristics of its components can be recognized already at the first month (No. 16, Fig. 1). From behind forward, the cranial vault is composed of three bones. First is seen the forward

and upwardly inclined plane of the interparietal bone. It consists of two light tables of bone separated by numerous trabeculæ, the diploic table being thick and richly vascular. Anteriorly, this table is abruptly pinched off at the interparietal-parietal suture. This point marks the line of attachment of the tentorium cerebelli on the inner surface.

Forward of this the calvaria is seen to be composed, as it were, of three arches (No. 16, Fig. 1). The first is formed by the parietal bone and its anterior end indicates the site of the parieto-frontal suture. If skiagrams No. 16 and No. 86, in Figure 1, are examined with a loupe, it will be seen that the inner table is denser, more compact than the outer, and that the middle table in this bone is less well developed than elsewhere in the calvaria, so that the parietal bone, at the top of the arch, presents in the skiagram the appearance of the outer table being almost directly applied to the inner. In the fresh state, the bone when looked at from above shows no vessels and is almost translucent. In the rat this segment is the thinnest part of the calvaria, just as in man the calvaria is thinnest at the parietal eminence.

The middle and anterior "arches" in the calvarial outline are formed by the frontal bone, the posterior end of the middle arch being the frontoparietal suture, while the anterior end of the anterior arch is at the frontonasal suture. At the junction of these two arches is the posterior of two diploic expansions whose presence in the frontal bone make it the most richly vascularized component of the calvaria. The area of bone in which these two expansions lie is comparable to that in which is developed the frontal sinus in man, the region of the frontal bone adjacent to the frontonasal suture and the supra-orbital ridge. When a freshly dissected rat cranium is viewed from above (Fig. 2) it is seen that the frontal bone has three vascular areas separated by two relatively avascular parts. The most posterior is adjacent to the frontoparietal suture, the anterior to the frontonasal suture, while the middle is

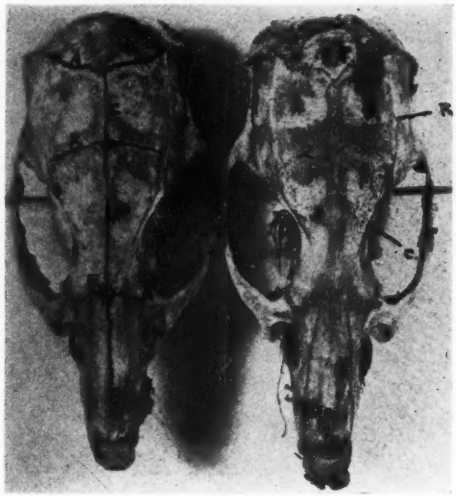


Fig. 2-*A*. Vascular anatomy of the rat calvaria. *Bones:* I. P., Interparietal; P., parietal: F., frontal; N., nasal. *Sutures:* A., interparietal-parietal; B., fronto-parietal; C., interparietal; D., interfrontal; E., frontonasal. *Vessels:* 1:2:4., para-sutural diploic vessels; 3., orbito-frontal diploic vessels. "C," "Supra-ciliary" canal; "R," temporal crest.

directed from the midline outward and somewhat forward; by means of a foramen there is communication between the vessels of the frontal bone diploe and those of the orbital cavity. This is the largest vascular foramen to be seen on the exterior of the rat cranium; it lies under cover of the supra-orbital ridge, about the midpoint of the orbital cavity. It is found in the great majority of young animals, but there is a tendency for it to be obliterated, especially in male animals, in which development of the supra-orbital ridge is increasingly marked with advancing age. It is to be considered as a homologue of the supra-ciliary canal in man of which anatomists as a rule do not give extensive description. LeDouble (4), however, states:

"One minute orifice, situated at the base of the incisura, or of the supra-orbital foramen, is the origin of a canaliculus whose course depends on the size of the frontal sinuses. When these do not extend vertically above the ophyron and, laterally, more than 1.5 cm. from the median line, the canaliculus arises vertically and, after a very sinuous course, loses itself in the diploe, which separates the

two tables of the anterior aspect of the bone. When the frontal sinuses are very extensive, it penetrates horizontally into the roof of the orbit, on the endocranial table of which it runs as far as the neighborhood of the orbital foramen, where it bends to course along the anterior wall of the sinus in which it opens at a variable height, unless it opens on the external aspect of the frontal bone."

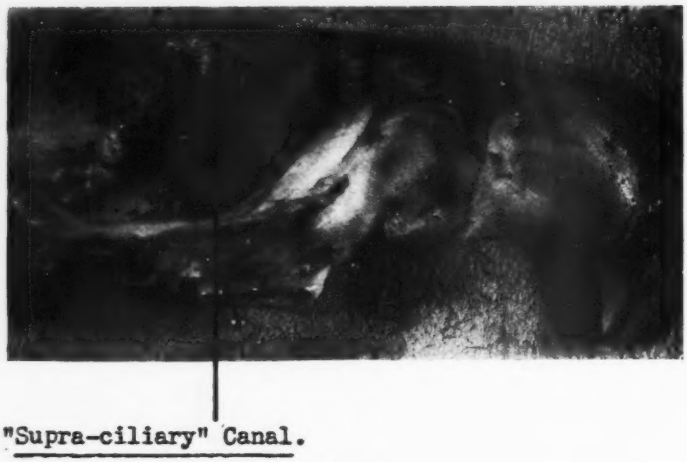


Fig. 2-*B*.

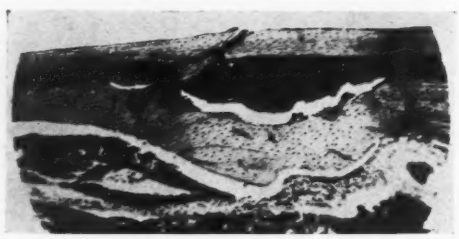


Fig. 2-*C*. The frontal-sinus homologue.

In 614 arches (307 skulls) d'Este found this canaliculus missing in only 26. It includes a small nervous filament arising from one of the end branches of the supra-orbital nerve and which is called in Germany "the nerve of Kobelt."

According to Ward (5), "this notch constantly presents the orifice of the canal which transmits nutrient vessels upward into the substance of the frontal bone. It is often of considerable size, sometimes double. It generally remains pervious in adults and may be called the '*supra-ciliary canal.*' Of 105 adult skulls, I found it present in 72." He found it constantly present in the fetal skull.

In the deer, where there is no frontal sinus, this area of the frontal bone forms the boss of the horn, and here the foramen is multiple and large in size; the same is true in the ox, where the frontal sinus is extremely extensive. In the rat, as the skiagram of the normal animal's growth is followed in this area, its functional significance will become apparent.

We regard, therefore, these two expansions of diploe as homologous to the human frontal sinus, although they have no communication with the nose and contain only a rich vascular marrow (Fig. 2-*C*).

This vascular arrangement in the frontal bone in the rat makes possible the marked changes which take place in this region in growth, changes which depend on the great functional activity of the maxillæ and mandible.

At the end of the first month of life the cranial skiagram shows (No. 16, Fig. 1) a typically infantile condition. As in man in infancy, the brain-case is relatively large and the snout (face) small. The greatest vertical height is behind, vertically above the spheno-occipital synchondrosis. The calvaria is curved, not only anteroposteriorly but also transversely. The bone

Fig. 3.

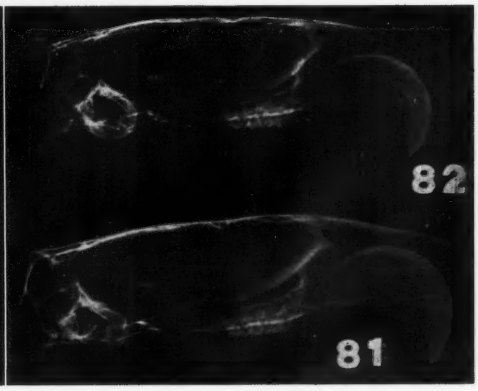


Fig. 4.

Fig. 3. Normal controls. No. 86, age 46 days; weight, 128 gm.; male: No. 82, age 97 days; weight, 193 gm.; male.
Fig. 4. Normal controls. No. 82, age 97 days; weight, 193 gm.; male: No. 81, age 170 days; weight, 266 gm.; male.

throughout, at this age, is very poorly calcified, as are the teeth, and there is no great difference in density between inner and outer tables of the skull.

By the sixth week (No. 86, Figs. 1 and 3), a marked change has taken place. There has been a rapid increase in size, not only in the brain-case, but to a relatively even greater extent in the snout, both anteroposteriorly and vertically; the height of the skull above the molar teeth has markedly increased. Thus, the outline of the calvaria is considerably straightened out and this has been contributed to by the pull of the nuchal muscles on the occipital-interparietal angle, associated with increasing use of the jaw; also, the teeth are larger and better calcified. There has been a well marked increase in density of the calvarial inner table, and a marked increase in size of the frontal sinus homologue. That the skull has also flattened in the transverse direction can be seen by the rise, toward the vertex, of the line of density which runs downward and backward from the region of the frontal sinus homologue, and which is caused by the increase in growth of the temporal crest. This is better seen in comparing Fig. 3, No. 86, with No. 82, where the temporal line has risen to a position just below the calvarial shadow. At this age, three months, the facial part of the skull has still further gained upon the brain-case in vertical height. The incisor tooth is very much larger and better calcified, the vault of the skull, except in the parietal region, where a little dome-effect remains, is practically straightened out, and there is seen the beginning of angulation at the frontonasal angle, with a simultaneous increasing density at the root of the nose and a progressive enlargement of the anterior component of the frontal sinus homologue.

These changes are seen to have progressively increased by the sixth month, at which date (No. 81, Fig. 4) the greatest vertical height is seen over the molar teeth. The angulation in the frontonasal region is more marked, the bone is denser, and the frontal sinus homologue proportionately larger, while by the end of the first year of life (No. 12, Fig. 5) it becomes evident that the chief differentiation change in the rat's cranium is related to mastication. The snout is at least half the mass of the total skull, and there has been built, to meet this physical need, a dense supra-orbital bar. The point of junction of the relatively light brain-case with the powerful snout has been strengthened, not only by the mechanical means of angulation at the point of maximum strain, but by the reinforcement of this area by an increased den-

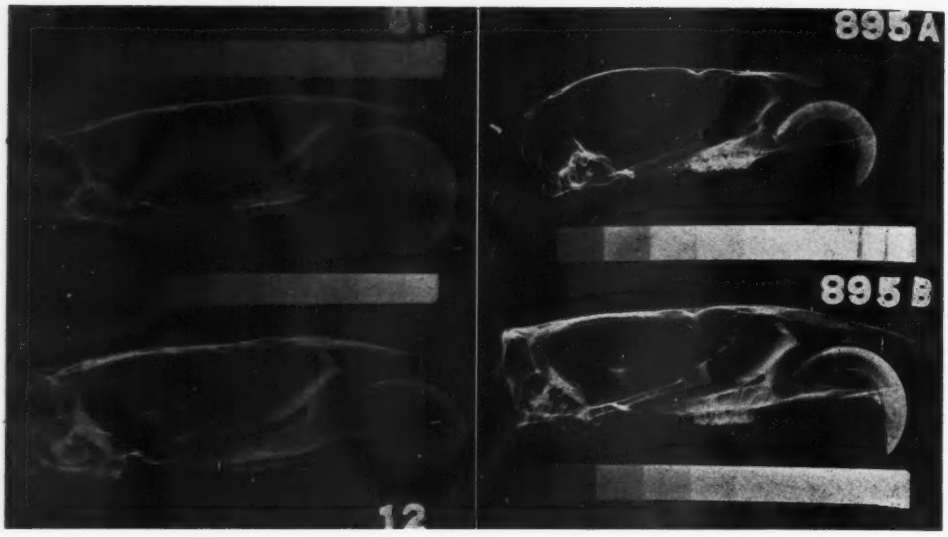


Fig. 5. Fig. 6.

Fig. 5. Normal controls, males. No. 81, age, 170 days; weight, 266 gm.: No. 12, age, 392 days; weight, 376 gm.

Fig. 6. The effect of hypophysectomy on the rat cranium. No. 895-*A*. Female hypophysectomized on the twentieth day of life. Age, 223 days; weight, 67 gm. No. 895-*B*. Female day-mate control; weight, 192 gm.

sity of the bone; and, while this has been laid down, the subjacent area has progressively increased in size as a marrow cavity. It is obvious that there has been at work the same basic mechanism of growth as is seen in the shaft of a long bone, as it progressively increases in diameter in growth, namely, subperiosteal deposition of bone and central resorption in the medullary cavity. Thus, the snout of the rat is modelled to suit its mechanical function, and comes to resemble in outline the design of a jaw of a mechanic's pliers.

The Effects of Hypophysectomy on Growth and Differentiation.—The crania of 40 hypophysectomized rats have been skiagraphed, and, as already stated, the hypophysectomized animals used for hormone-assay are operated upon when about from 50 to 70 days old. The extent of the resultant deformity of the cranium depends upon the age at which the operation is done, being more marked the earlier it is performed, and the longer thereafter the animal is allowed to survive.

No. 895-*A*, Figure 6, is a female rat hypophysectomized on the twentieth day of life, and allowed to survive till seven and a half months old. No. 895-*B*, Figure 6, is also a female born of the same stock on the same day, weighing the same as the previous animal did on the day of operation, and living alone with it in the same cage, being sacrificed on the same day. Ten days after operation it weighed 36 gm., and on the day of death 67 gm., so that at death it had almost doubled its minimum post-operative weight. The control was almost three times heavier in body weight; its thyroid gland was almost three times heavier, its adrenals seven times, and its ovaries twelve times heavier. The operation was complete and the profound influence of pituitary lack on growth in general and particularly on other endocrine structures is obvious.

When a young adult rat is hypophysectomized, one about 100 gm. in weight, growth immediately ceases. It has, however, been shown (7 and 8) that if very young animals are used (weight from 25 to 35 gm.), growth does not stop, but that

they continue to gain until the weight is about double that at the time of operation. This estimate of "growth" is based upon gain in weight; the nature of the growth, which characteristically follows hypophysectomy, becomes evident from study of the skiagram and measurement of the skull.

The skiagrams in Figure 6, Nos. 895-*A* and *B*, are enlarged one and one-half times; *B*, the control animal, is normal in size for a female in the eighth month of life. The magnification in Figure 1 is the same and, if 895-*A* is measured from the supra-occipital-interparietal suture to the tip of the nasal bone shadow, it will be found to be considerably shorter in this dimension than its control. But, on the other hand, it is considerably longer than No. 16 (Fig. 1), the length of which is normal for a rat of 31 days, although 895-*A* was hypophysectomized on the twentieth day of life when, it is to be presumed, its cranial length was less than No. 16 measures. The cranial length of 895-*A* is equal to that of No. 86, which is 46 days old. If a curve is constructed from the figures given by Donaldson for naso-occipital length, from the twenty-third day to the tenth month, the values being multiplied by 2.5, it becomes evident that the control animal at 223 days of age has a total cranial length in agreement with Hatai's figures; whereas, the hypophysectomized animal's naso-occipital length would have, on such a curve, a value corresponding to an animal of 64 days of age. The skull of the animal, hypophysectomized on the twentieth day of life, has very evidently grown in length.

Compared with the control 895-*B*, measured on the skiagram, it shows a retardation in cranial length of 14 per cent. Also on the skiagram, the cranial height, taken above the occipito-sphenoid synchondrosis, is the same in both animals, but, anteriorly, measured vertically above the first molar tooth, there is retardation in the animal operated upon, of 16 per cent. The most striking fact that becomes evident, however, is that, while the hypophysectomized animal's skull has grown it has retained the early infantile proportion of snout to brain-case. If one compares it with Nos. 16 and 86, its outline resembles much more closely the former than the latter. It is clear that the brain-case has suffered less than the facial part of the cranium or, in other words, that there has been a more marked failure in differentiation than in growth. From our study of the normal rat crania we have seen that differentiation in growth chiefly subtends the function of mastication; thus, when differentiation is chiefly affected its immediate reflection appears in the masticatory apparatus.

Measurement of the actual crania confirms these observations and demonstrates the singular nature of the change. In Table I, Hatai's maximum, mean, and minimum cranial dimensions are given for

TABLE I.—CRANIAL DIMENSIONS OF HYPOPHYSECTOMIZED AND CONTROL FEMALE RATS COMPARED WITH HATAI'S MEASUREMENTS FOR NORMAL FEMALES

	Maximum	Mean	Minimum	895-*B*	895-*A*	Retardation Percentage
1. Total cranial length	44.5	41.5	38.9	43.5	**36.5**	**16.1**
2. Fronto-occipital length	28.2	26.4	24.9	26.5	**23.5**	**11.4**
3. Nasal bone	17.8	15.7	14.4	17.0	**13.0**	**24.0**
4. Cranial height	12.2	11.1	10.3	11.0	11.0	*nil*
5. Cranial width	16.2	15.1	14.4	15.25	15.0	*nil*
6. Upper incisor (extra-alveolar at 8 months)		9.0		8.0	**6.0**	**25.0**
7. Lower incisor (at 8 months)		12.0		12.0	**8.0**	**34.0**
8. Upper diastema (at 8 months)		12.5		12.5	**10.0**	**20.0**
9. Lower diastema (at 8 months)		7.0		7.0	**4.0**	**43.0**

1. End of occipital to tip of nasal bone.
2. End of occipital to frontonasal suture.
3. Frontonasal suture to tip of nasal bone.
4. Perpendicular height above occipito-sphenoid synchondrosis.
5. Width at posterior zygomatic roots.

normal adult female rats together with Nos. 895-*A* and *B*. It is apparent that the control animal's measurements rank somewhat above the mean. Comparing the measurements of the hypophysectomized and the control, it appears that the greatest disturbance of growth in the hypophysectomized animal's cranium is in the anteroposterior direction, both cranial height and width showing no failure in growth. Occipito-nasal length is 16.1 per cent less and fronto-occipital length is 11.4 per cent less than the control, but the chief defect is in the nasal bones, which are almost a quarter less long than normal. The extra-alveolar length of the upper incisor tooth is affected to a similar degree, while that of the lower incisor is considerably more affected. The upper maxilla is 20 per cent less than in the normal animal, as indicated by the length of the diastema. Even more marked is the resultant defect on the lower incisor and mandible, as shown by a 34 per cent retardation in the lower incisor and a 43 per cent in the body of the jaw. This last fact may possibly be accounted for by the view that in growth the upper jaw acts as the "pacemaker" for the mandible.

Collip (8) is of the opinion that growth in the absence of pituitary tissue in very immature animals ". . . shows that in early stages of ontogenetic development the organism must have an extra-hypophyseal source of growth-stimulating substances," and he cites "growth in length in reptiles and amphibia, which is largely independent of the pituitary," as a phylogenetic precedent for the ontogenetic growth that takes place in the hypophysectomized immature animal. But this cannot be regarded as an explanation as to why, after hypophysectomy, growth more clearly fails in the face than in the brain-case, nor why in the brain-case itself growth in the anteroposterior direction should be retarded, while, in the vertical and transverse directions it would appear to be unaffected. A possible explanation suggests itself in that growth of the brain-case as a whole is undoubtedly dependent upon growth of the brain; in the hypophysectomized animal the brain is not so large as in the control and can be accommodated adequately in a brain-case which is 11.4 per cent shorter than normal, and whose height and width are normal. Growth in the forward direction would appear to be largely dependent upon or at least associated with forward growth of the face. The view is generally held that an important factor in facial growth lies in the masticatory effort and particularly is this true in the case of the lower jaw, in which the adequacy of dental occlusion also plays a part. In the hypophysectomized rat the muscles are poorly developed, of poor tone, and readily fatigued; appetite also is less. These facts must be taken into account in estimating the cause of the facial hypoplasia, but it is also evident that the absence of the anterior lobe of the pituitary imposes a handicap on growing bone in general which tends, peculiarly and particularly, to affect the growing snout, owing to the cancellous type of bone of which it is largely composed, the brain-case being structurally of more compact bone, which, while undoubtedly affected by hypophysectomy, is so to a less degree.

The skiagrams of the calvaria of these two animals show marked hypoplasia in its cancellous element—the middle table. This is very clear in the interparietal bone, especially posteriorly, where the three tables can no longer be distinguished; but it reaches its maximum in the parietal bone where the skiagram presents the effect of only one table being present. This does not mean that there is, histologically, complete obliteration of the middle table in this area, but that trabecular deterioration and marrow aplasia are present to an extent where the three tables appear as one in the skiagram.

The frontal bone is similarly affected in the areas between the vascular expansions, which suffer to a marked degree. This is particularly true in the anterior expansion which occupies the site more closely homologous to the human frontal sinus. It is not only much shorter anteroposteriorly (two-thirds the length), but is also much

less in its vertical measurement, while its outer table, instead of forming the convexity of the frontonasal angle, is depressed and somewhat concave, and its contained marrow aplastic.

A similar condition is present in the basal bones of the skull which are considerably less "expanded" than normal, and in length are 20 per cent shorter than in the control. The ethmoid and its cribriform plate, as well as the zygoma, are considerably smaller.

Marked changes occur in the teeth after hypophysectomy (10 and 11). These are particularly well seen in the incisor tooth, which shows characteristic changes. The tooth is considerably smaller than in the control, being approximately two-thirds normal in size. It has lost its almost semicircular form, and presents the appearance of the chord of the arc which it forms being considerably shortened. The gradual tapering of the walls of the tooth, as it is followed backward toward its base or "root," which characterizes the normal tooth, disappears. The pulp cavity is largely obliterated, so that, instead of the tooth being for the most part a hollow cylinder, it becomes largely a solid cylinder. The "root" is markedly abnormal in structure, thickened, and its outline irregular and notched, showing excrescences at the base.

During the seven months of post-operative survival in this animal, not only has the body weight almost doubled, and the skull grown, normally in certain directions and abnormally in others, but there has occurred a definite increase in density of the cranium. In comparison with No. 16, which it resembles in outline, and No. 86, which it approximates in length, it is apparent that its density is considerably greater than in either, even though it is much less dense than its own control, No. 895-*B*. It appears that calcium has been added in a measure which, while not adequate for its age, is still excessive both for its size and stage in differentiation. This may be looked upon as a process of relative sclerosis. The increasing acquisition of calcium may be considered as resulting

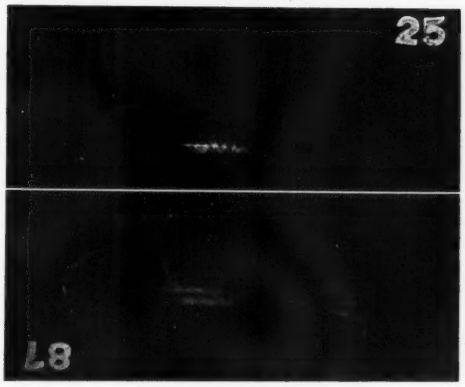


Fig. 7. The early effect of hypophysectomy. No. 25. Male, hypophysectomized on the eighteenth day of life, weight, 35 gm. Skiagram on the thirty-sixth day, weight was then 44 gm. No. 87. Male control, age, 38 days, weight, 90 gm.

from that small increment in constituent elements which the cell acquires in virtue of what may be regarded as its integral growth potential, as the proceeds of its daily metabolism which still takes place, in the absence of the anterior lobe of the pituitary, although with lessened vigor, despite the fact that neither resorption nor expansion keeps pace. Thus, calcium is slowly added to a structure in which resorption lags and in which "expansion" is consequently greatly retarded.

Summarizing the effects of hypophysectomy on the growth and differentiation of the young rat cranium:

(1) There occurs a marked decrease in vascularity of the bone throughout the cranium, affecting the individual bones in the order of richness of their normal vascular supply.

(2) As a result, the processes of *pari passu* resorption and deposition, normally concerned in bone growth, are seriously impeded, but it would appear that the former is more affected than the latter.

(3) All growth does not cease, but as a result of the daily tissue metabolism, which, however, is undoubtedly depressed, there is for a time, during the normal growth period, a slow increment of the constituent elements, possible in virtue of the "integral growth potential" acquired by

the tissue in phylogeny, and there results a dimensional increase which, however, is not equal in all directions. It would seem as if a more adequate response results "passively" to growth in other tissues, such as the brain, than occurs in areas where full development apparently depends upon an "active" functional use of the areas, as a contribution to full differentiation.

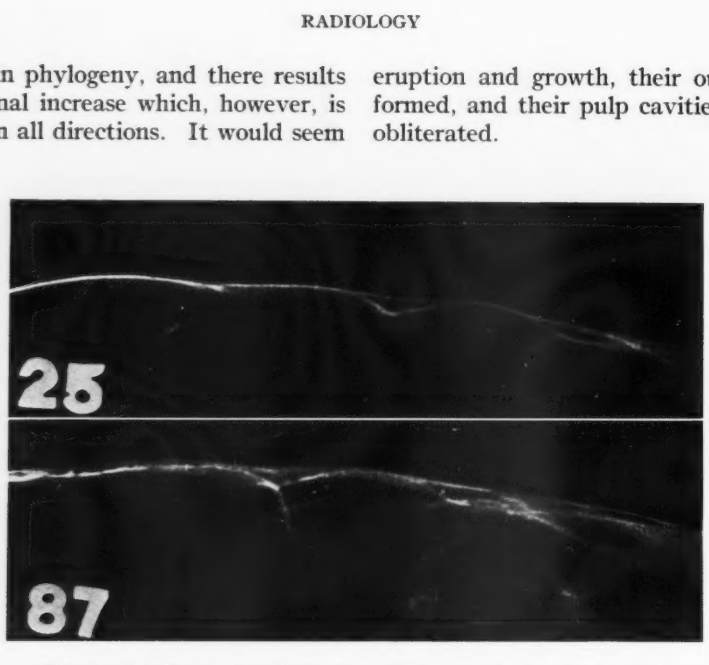


Fig. 8. The frontal sinus homologues of No. 25 and No. 87, magnified about 12 times. Note the disappearance of diploe from the frontal and parietal bones in No. 25.

(4) Thus, the brain-case grows more adequately in its transverse and vertical directions, inadequately in its anteroposterior.

(5) The snout, or facial part of the cranium, suffers relatively more than the brain-case; growth is inadequate in all directions; which may be due to the fact of its being largely composed of richly vascular cancellous bone which is profoundly influenced by hypophysectomy. Thus, there results the retention of an infantile proportion of face to brain-case.

(6) The calvarial diploe is hypoplastic and in the skiagram this appears earliest and most readily where the table is normally thinnest, *i.e.*, in the parietal region.

(7) There is marked hypoplasia of the frontal sinus homologue (Fig. 8).

(8) The teeth are markedly retarded in eruption and growth, their outline is deformed, and their pulp cavities are largely obliterated.

How soon after operation in a young animal the foregoing changes, characteristic of hypophysectomy, can be recognized in the cranial skiagram is a question of considerable interest. Since cranial growth and development is rapid in the first weeks of life, especially in the snout, in association with eruption of the teeth and the beginning of mastication of solid food, the changes following on hypophysectomy are more clearly apparent the earlier in life the operation is done. Unfortunately, however, in very young animals the difficulty of the operation is not only greatly increased technically, owing to the very small size of the field, but the mortality rate in animals operated upon prior to weaning is considerably higher.

Rat No. 25 (Fig. 7) was hypophysectomized on the eighteenth day of life by Dr. Selye, the youngest age at which the operation has been successfully performed in the rat. It was sacrificed after an interval of 18 days, during which time it had added 25 per cent to its weight at the time of operation. At this period in life the nor-

mal animal as a rule approximately trebles its weight (12).

When compared with a standard control of the same stock and approximately the same age (two days older), there is no significant difference in the two animals in either cranial height or width, but, in the hypophysectomized animal, the total cranial length is 10 per cent less, the frontooccipital length 5 per cent less, while already the greater impediment to growth is reflected in the nasal bones, which are 21 per cent less in length than those in the control animal. The skiagram shows, at this short interval after operation, changes typical of hypophysectomy; the calvarial contour is of an earlier infantile type, the middle table cannot be distinguished posteriorly in the interparietal bone, and in the anterior part trabeculæ are not seen. Diploe is not apparent at all in the parietal bone (Fig. 8), while in the frontal the diploic expansions are smaller, especially the anterior one, at the root of the nose, which, anteroposteriorly, is markedly shorter. The difference in length of the nasal bones is striking. The bones of the cranial base are very much smaller, while those at the interparietal-occipital angle are markedly less differentiated, possibly indicating retardation of development of the nuchal muscles.

Already in the incisor tooth can be recognized the beginning of those changes of which full development is so clearly seen in No. 895-*A*. The tooth is smaller, there is angulation of its anterior wall at the junction of the proximal and middle thirds, at which site the wall is already thickened and definitely increased in density, while, toward the anterior end, the pulp cavity is less clearly defined, indicating its commencing obliteration. Eighteen days after operation it is clearly apparent that this animal has been hypophysectomized.

The general changes in the skeletal system, following hypophysectomy, are chiefly an osteoporosis simplex with disorganization of the trabecular structure of the bone and marrow aplasia, well seen in the lower end of the femur of a hypophysectomized rat. A similar condition may follow

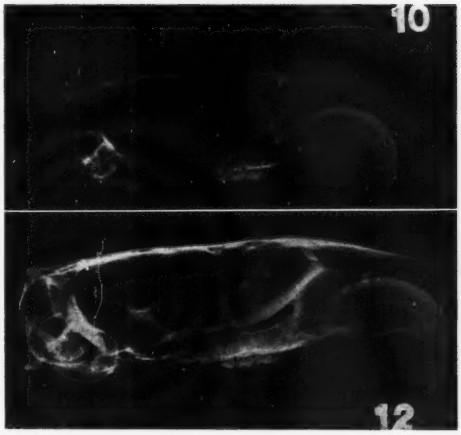


Fig. 9. The effect of low calcium diet on cranial differentiation and growth. No. 10, male, age 335 days; weight, 162 gm.: No. 12, male, age 392 days; weight, 376 gm.

such general states as starvation, avitaminosis or unhygienic surroundings, and consequently it has not been regarded as a change specifically following hypophysectomy. However, it is clear that the changes in the young cranium following hypophysectomy, as above described, constitute as a whole a syndrome specific for hypophysectomy in early youth. The general conditions mentioned undoubtedly can affect the structure of the bones of the skull and of the teeth, as well as the relative proportions of the cranium, but the general picture resulting in such cases will not easily be confused with that occurring in an animal that has been hypophysectomized in early life, and whose diet, vitamin intake, and surroundings have been satisfactory.

This is demonstrated in No. 10, which is the skiagram of a rat almost one year old, that, since birth, has been on a diet containing only about one-tenth of the calcium content of the routine diet, and which is otherwise adequate. Both its parents had been similarly treated for some time previous to its conception, and the mother also throughout gestation. That there has resulted a marked inhibition of growth is apparent in the fact that its weight is less than 50 per cent of that of a normal animal

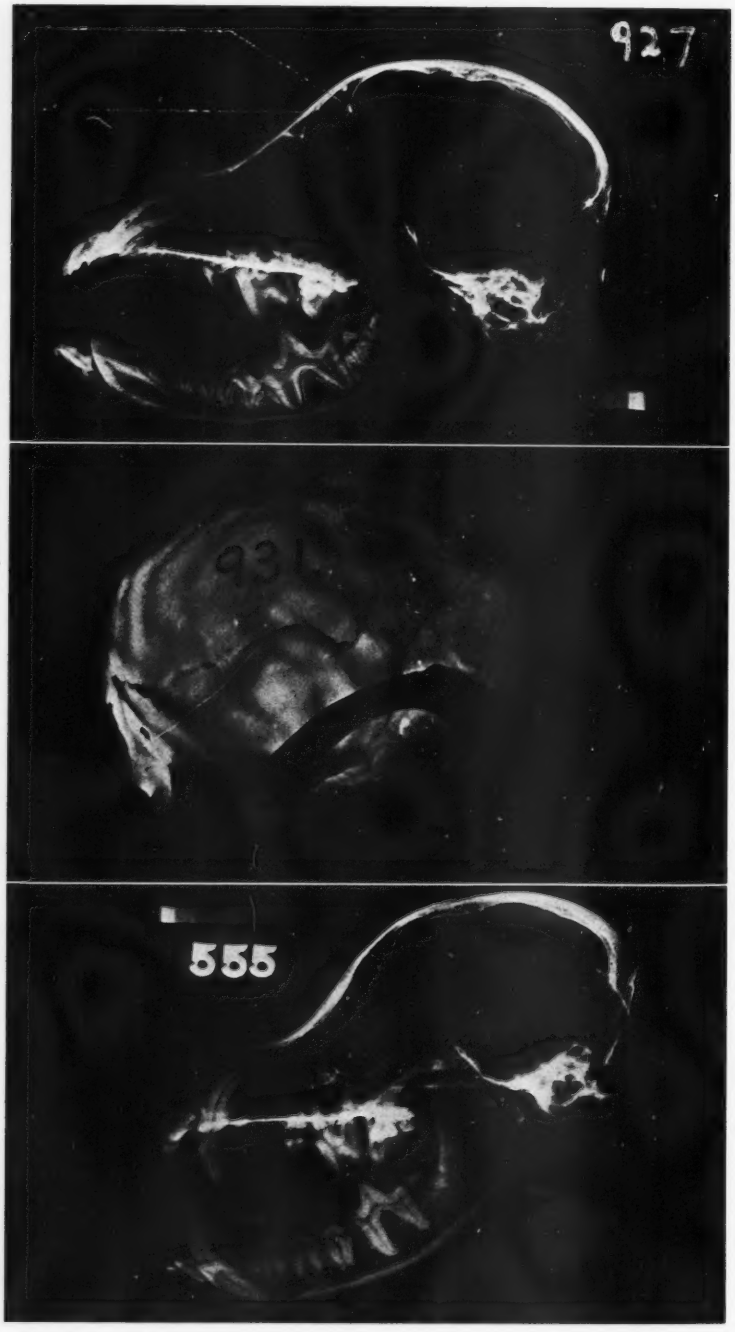


Fig. 10. The effect of hypophysectomy on the cranium of the dog. Dog No. 927, hypophysectomized about the fifth week of life. Skiagram one year later. "A," Position of "supra-ciliary" canal, with metal stilette in it; "B," Upper limit of hypoplastic frontal sinus, beyond which is cancellous bone. Dog No. 931. Another animal of same series, hypophysectomized about the fifth week, surviving one

(*Continued on next page*)

about its own age. There is growth failure reflected, not only in total cranial length, but also, quite markedly, in the length of the nasal bones. Full differentiation has not taken place and a well marked fronto-nasal angle is absent, although there had been a fair growth in facial height above the maxilla. So poor is calcification that the calvarial tables show merely as fine lines. There is, however, no obliteration of diploe in the skiagram; on the contrary, the appearance suggests an increase in this table, but this is only apparent and results from such a profound decalcification of both inner and outer tables that the middle table appears relatively increased in thickness. Although there is an osteoporosis simplex present to a marked degree, the calvarial architectural structure is the reverse of that found after hypophysectomy. The incisor tooth, although markedly smaller than the control, is normal in outline, being almost semicircular. While the anterior wall of the tooth is considerably thicker than normal, resulting in a narrowing of the pulp cavity, there is no angulation in it and both walls of the tooth are normal at the proximal end, as they taper off to the "root." The dentin is of poor quality and there has been a fracture at the tip of the tooth. It is true that there has been a diminution in size of the pulp cavity, but the condition in no way resembles that which is found after hypophysectomy. This cranium could never be mistaken for that of a hypophysectomized animal.

The Effect of Hypophysectomy on the Cranium of the Dog.—No. 927 (Fig. 10), a puppy of unknown, but certainly very mixed stock, the dominant strain being apparently fox terrier, was hypophysectomized by Dr. Carl Bachman at about the fifth week of life. Its litter-mates varied so greatly in size, markings, etc., that none could be justifiably used as a control. It is clear, however, that after a year's survival the cranial defects seen are, in the main, of the order of those found in the rat after hypophysectomy. The body length from the tip of the nose to the root of the tail had increased only about 9 per cent. It retained throughout its puppy characteristics and the cranium is largely that of a puppy. The snout has suffered severely, and there is crowding of the teeth due to hypoplasia of the jaws, particularly in the pre-maxillary region, where there is incarceration of the milk teeth and failure of eruption of some of the permanent teeth. The pulp cavities are reduced, especially toward the points; there is a marked degree of malocclusion and a very overshot mandible. This is not due to overgrowth of the latter, but from failure in forward growth of the upper jaw—a good example of "progeniacism."

The calvarial outline has retained the highly convex contour of early puppyhood; the diploe is minimal in amount throughout and, anteriorly, in the region of the cancellous bone into which the frontal sinus should have grown, resorption has failed and the frontal sinus is in consequence markedly hypoplastic. The anatomical relationship between the "supra-ciliary" canal and the area of bone into which the frontal sinus should have extended, is demonstrated by a fine steel wire, placed in the canal.

Throughout the vault of the skull, the diploic hypoplasia is more evident where the blood supply is anatomically less; normally, and conversely, the hypoplasia is less where the diploe is normally thicker and more vascular, *i.e.*, in the parts overlying the cerebral sulci, where communicating vessels pass from the dura mater to the diploe. Thus the appearance is created of "convolutional impressions" on the vault (Fig. 10, No. 931). These have not been produced by pressure atrophy, but have occurred passively and are due to the

year. The calvarium has been transilluminated to show the convolutional impressions. The cancellous bone in the frontal area, into which the frontal sinus should normally extend, has been injected from the "supra-ciliary" canal. Its vessels are continuous with those in the diploe elsewhere. Dog No. 555. Depancreatized as young adult, hypophysectomized twelve days later; skiagram 7 months thereafter. Note the very marked obliteration of the dental pulp cavities.

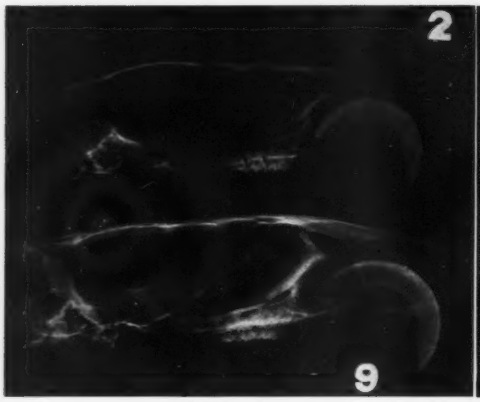


Fig. 11.

Fig. 12.

Fig. 11. The effect of untreated hypophysectomy. No. 2. Male, hypophysectomized on the forty-seventh day. Skiagram taken at 237 days, as compared with skiagram of slightly younger normal male at 210 days.

Fig. 12. The effect of treatment with "Q" hormone on the hypophysectomized rat. (Purified somatotropic hormone.) No. 7. Male, hypophysectomized on the forty-seventh day, treated twice daily for 53 days. No. 2. Male, hypophysectomized on the forty-seventh day, no treatment.

fact that a general diploic hypoplasia produces its greatest apparent effect in areas in which the bone is normally thinnest, *i.e.*, over the convolutions.

To a less degree such an appearance is more or less characteristic of young crania, or at least of crania which are thin, with the middle table of the skull poorly developed. In this instance the appearance is produced first by the retention of an infantile characteristic, subsequently enhanced by diploic atrophy.

An effect of the same order is apparent to a less degree in the skiagram of the "Houssay dog" (pancreatectomized-hypophysectomized), a photograph of which has been published by Collip (16). This animal, a female of mongrel "terrier" stock, was sexually mature when the pancreatectomy was done; hypophysectomy followed 12 days later, abortion following the second operation. She was killed after seven months, when the skiagram (Fig. 10) was made. Since there was no control animal, it is impossible to be certain to what degree the shortness of snout is due to the hypophysectomy. However, the presence of a well marked progeniacism, the incisor teeth in the mandible overshooting the upper teeth, definitely indicates failure in forward growth of the pre-maxillary part of the snout, as does the incomplete development of the frontal sinus. This is about half its normal size, the part of the bone in the supra-orbital region into which it normally extends, in the dog, being still marrow-containing cancellous bone. The conclusion is justified that the animal, although sexually mature, and pregnant when the experiment began, was not completely grown, and that the cranial development was arrested by hypophysectomy.

The dental condition is extremely interesting; there is not only marked malocclusion and deformity of certain roots, but the pulp cavities of all the teeth have suffered an extreme degree of obliteration, those of the canine teeth being vestigial. Postmortem in this animal there was found parathyroid atrophy, a condition found, by Houssay (17) and Collip (8), to occur in dogs so treated.

The Effect of the Administration of Purified Somatotropic Hormone on the Cranial Defects Produced by Hypophysectomy.—The crania of 21 hypophysectomized animals, treated with various batches of purified somatotropic (growth) hormone (13 and 14), were examined. The routine test object for such hormone-fraction is the rat

hypophysectomized when it weighs about 100 grams. Rat No. 2 (Fig. 11) is a male, hypophysectomized at 47 days (98 grams) and allowed to survive 238 days. No. 9 is a normal male, 210 days of age and weighing 315 grams. The former shows the defects typical of hypophysectomy performed on an animal of that stage in growth. No. 7 (Fig. 12) is another male, hypophysectomized at this stage, subsequent to which it was treated with a highly purified growth fraction (Q.40.A.) for two months.

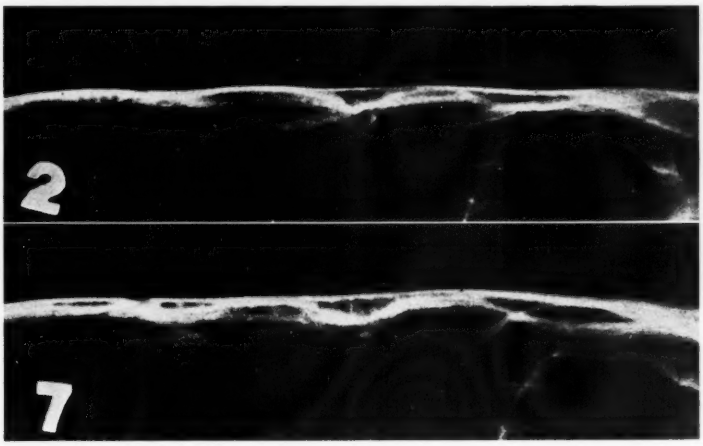


Fig. 13. The effect of purified somatotropic hormone on the frontal sinus-homologue. Comparison of the diploe and frontal sinus-homologues in hypophysectomized—untreated and hypophysectomized—somatotropic hormone-treated rats. Note the recovery in the latter.

The defects have largely been made good. The calvarial outline is that of an animal markedly more advanced in differentiation than the untreated animal; the snout is better grown, the height of the snout above the molar teeth being obviously greater. There is not only complete recovery of the middle table in the interparietal bone, but it could even be considered excessive. In the parietal bone diploe can be seen, while anteriorly the frontal sinus homologue is not only normal in size, but appears to be larger than normal (Fig. 13). Above it there is an indication of the formation of a frontonasal angle, and in this region the skull is better calcified than in the untreated animal. There has been complete recovery of the bones of the cranial floor in marked contrast to the poorly expanded state of those structures in the untreated animal; in the basi-sphenoid there is complete healing of the trephine opening, whereas this defect is still present in the untreated animal.

The incisor tooth in the treated animal is a source of very important information. Were this structure not included in the skiagram, it would be impossible to tell that the animal had ever been hypophysectomized, since the rest of the cranium has completely recovered. The anterior two-thirds of this tooth, however, still indicate clearly that this operation had been done. There has been, however, almost complete recovery in the proximal part of the "root" of the tooth, which is normally tapered and the pulp cavity in this situation is almost entirely normal. There is, however, a marked indentation present on the anterior surface of the root, the part proximal to which represents the portion grown during the hormone treatment.

It has not been found possible so far to continue treatment until a completely normal tooth results, since, with continued injections, the hypophysectomized animal,

treated for more than 30 days with a purified growth extract, ceases to manifest any further growth response (15).

The Influence of Hormone Factors on Cranial Structure.—We have already indicated, in noting that the earlier in life an animal is deprived of the influence of the anterior pituitary upon growth the greater is the resultant, characteristic deformity, that its cranium may serve as a criterion in judging the normality or abnormality of the growth process in the past, and that deformity may serve as an index to the time of occurrence of a retarding influence. To be considered as normal, the cranium must have attained a certain size relative to the age and sex of the animal, and its component parts must bear a certain proportion relative to each other. But in addition, those individual components at any given time in growth, whether during the active phase or later in adulthood, must present a certain density, relative to their architectural function.

In the earlier stages of growth the cranium is relatively less calcified and its calcium is more mobile than when active growth is over. This facilitates the "expansion" which progressively characterizes bone in growth, but as the process proceeds and the final architectural pattern is completed, there follows a period in which the tissues become more heavily calcified, so that consolidation of the structure takes place and this is reflected in the skiagram as an increasing density, more especially marked in certain areas where functional stress occurs. But it has been shown, in the normal healthy animal, that this structural density cannot in any way be regarded as "permanent." Calcium and other salts are constantly being lost and replaced, so that even when dimensional growth is over and the fully adult form achieved, growth can be considered still to be taking place at a vegetative or maintenance level. Chiewitz and Hevesy (18) have estimated that the average time which a phosphorus atom remains in the organism of a normally fed rat is about two months and they conclude that the formation of bone is a dynamic process, the bone continuously taking up atoms which are partly or wholly lost and replaced by others. They also demonstrated that, with a given intake, rapidly growing structures, such as the incisor teeth, take up atoms to a greater extent than others, like the molar teeth, which, once erupted, take up less than the average per gram of skeleton.

The level at which such mineral interchange maintains a positive balance accounts for the variations in density that are to be found at all ages in an animal of such pure and stable stock as the white rat. In the adult rat, as in man, the tendency with advancing age is not toward demineralization but toward a progressive increase in density, particularly noticeable in the male animal.

Apart from pathologic processes there are many general conditions which are admittedly capable of producing change in bone density, and the means by which they act may not always be clear, but the influence of hormones on calcium metabolism is specific and of prime importance.

Scientific investigation of calcium metabolism in man is a matter of much difficulty, chiefly due to the wide range of the materials constituting his diet and the reluctance with which he will submit himself to subsistence for sufficiently long periods of time, upon the type of diet which makes the estimation of the calcium balance practicable. The rat, however, is an ideal animal for this work for which it has been in extensive use. We have had an opportunity of radiographing the crania of a certain number of rats used in the various investigations of calcium metabolism conducted by workers in this laboratory. Thus it has been possible to be assured not only of the physiologic normality of the animals in use, but of the exact daily intake and elimination of calcium for several weeks prior to the period of experimentation, at the end of which it has been possible to correlate the radiographic appearance with the recorded measured effects of the treatment upon the animals' calcium metabolism.

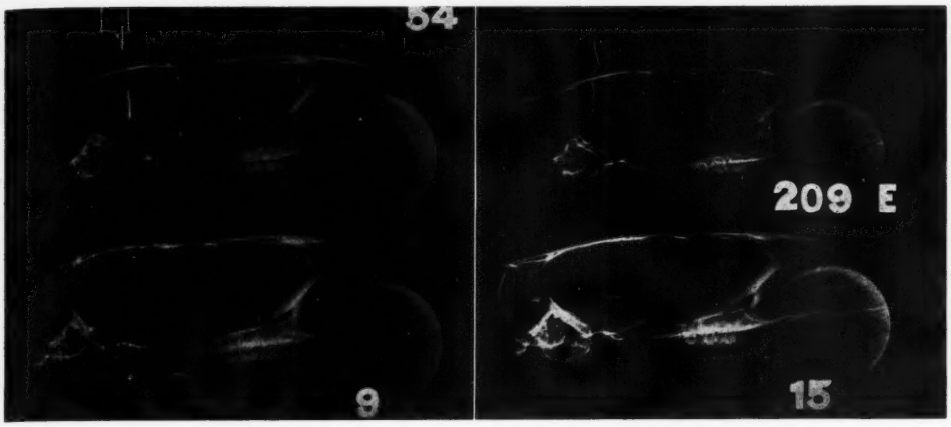


Fig. 14. Fig. 15.

Fig. 14. The Effect of thyroid by mouth on cranial density. No. 54, age 212 days; weight, 136 gm.; male. Two gr. desiccated thyroid, daily by mouth, for 18 days, during which period there was a loss of weight of 34 gm. No. 9, male, age, 210 days; weight, 315 gm.

Fig. 15. The effect of thyreotropic hormone on cranial density. No. 209-*E*. Treated with T.G. 12, twice daily for 55 days; age, 87 days; weight, 138 gm. No. 15. Untreated; age, 91 days; weight, 140 gm. Both are intact animals.

(A) FACTORS PRODUCING DEMINERALIZATION (OSTEOPOROSIS SIMPLEX)

(*1*) *Thyroid Feeding.*—No. 54 (Fig. 14) is the skiagram of one of a series of rats investigated by Pugsley and Anderson (19); it is a male 212 days old, the control being a normal male two days younger. For 45 days prior to treatment it was upon an otherwise normal diet in which the calcium content had been reduced to nearly balance the calcium excretion, the animal being in a positive Ca balance of 2.7 mg. per day. It was then given two grains of desiccated thyroid gland daily by mouth for 18 days. The skiagram shows a well marked general demineralization in the cranium and teeth, particularly noticeable along the vault, in the petrous portion of the temporal bone, and in the frontonasal region, where the effect is to make the anterior component of the frontal sinus homologue appear relatively enlarged. Careful inspection, however, reveals the fact that it is not larger than in the control, but that the area over it, in the treated animal, being less dense, has been more completely penetrated. The tooth changes are noticeable both in the molar and incisor teeth. In the latter, at first sight, the difference in general density does not appear to be very marked, but comparison both of the thickness and density of the dentin of the anterior wall near the "root" shows clearly the change; there is a well marked decalcification of this area in the treated animal. It may be as well to point out that without the penetrometric standard on both skiagrams one might hesitate in attaching full significance to the above changes. One is further strengthened in reading the above skiagram by reference to the physiologic findings. Dr. Pugsley found that during the period of treatment in this particular animal the fecal calcium output rose from 4 to 10 mg. per day, and that the animal was in a negative calcium balance of about 5 mg. daily. In this group of six rats, whose body weight averaged approximately 250 gm. at the beginning of the experiment, about 70 gm. were lost under thyroid treatment. This animal, treated for a considerably shorter period, lost 34 grams. The calcium lost is chiefly eliminated in the feces, although there is a decided increase also in the excretion of calcium in the urine. During treatment the basal metabolic rate rose progressively, thus accounting for the loss

in weight, while the general cranial demineralization, seen in the skiagram, is accounted for by the negative calcium balance.

(*2*) *Thyreotropic Hormone.*—Although the hypophysectomized animal is, in certain respects, more responsive to the administration of a purified thyreotropic fraction than the intact animal, it presents the disadvantage, as has been shown, of having a profound cranial dysplasia, in the presence of which it is hard to distinguish a specific thyreotropic influence. The crania of 36 intact young adult rats treated with thyreotropic hormone in relatively large dose, twice daily, and for varying periods of time, were examined.

No. 209-*E* (Fig. 15) was one of a group of six rats so treated for the last 55 days of life, by Dr. Anderson (20). Compared with the control animal which is four days older, and but 2 gm. heavier, it shows a marked general demineralization of the cranium and teeth. The cranial proportions are normal and there certainly is no evidence of overgrowth; the animal is intact. Even on the administration of this hormone fraction, in this laboratory, to the hypophysectomized animal there has thus far never resulted any growth (8), nor is there any evidence of interference with growth, as far as this can be inferred from body weight, for during the period of treatment the record shows that it gained 105 grams. In another group of animals similarly treated, Pugsley (21) was able to show that there resulted an increased elimination of calcium in the feces during the period of elevation of the basal metabolism. The animals, however, were not in marked negative calcium balance. It has been shown that within the first few days of such treatment the basal rate rises on the average about 35 per cent, followed by a secondary rise in about a week which, however, is not maintained. The rate gradually subsides, despite the continuance of treatment, to normal or below normal. Collip suggests that the first rise is due to the sudden discharge of existing stores of thyroid hormone into the blood, while the second results from the glandular hyperplasia induced by the hormone.

The prolonged treatment in the group including No. 209-*E* resulted in the development of a condition of resistance, as shown by two facts. At postmortem this animal's thyroid was hypoplastic and weighed only 11 mg., while 3.5 c.c. of serum from the pooled blood of the six animals inhibited two hundred times the minimal effective dose of thyreotropic hormone in a hypophysectomized rat. While it might seem reasonable to presume that the acquisition of this state, which Collip and Anderson have suggested may be due to formation of a specific antihormone, with an associated thyroid hypoplasia, might be expected to result in an effect of an order opposed to the demineralization, induced by thyroid stimulation, it is obvious that this did not occur in the animals of this group, or in any of the other 30 crania examined. Without exception all showed significant demineralization. A speculative explanation of this might be found in the fact that prolonged treatment, which produces an antithyreotropic factor, is associated with a basal metabolism at a chronic subnormal level. Despite the fact that the body weights are close, one cannot altogether avoid concluding that the injected animal, due to a continued low metabolism, was the less well grown; unfortunately, there is no record as to whether it was obese or not.

(*3*) *Adrenotropic Hormone.*—The crania of 21 young adult rats, treated with adrenotropic hormone, were examined. Dosage ranged up to 1 c.c. twice daily, over periods of from two weeks to two months. In all of them evidence of decalcification was seen, in varying degree, but there is felt to be considerable doubt as to this being a specific effect.

The hormone fractions used undoubtedly contained a certain amount of thyreotropic hormone, incidental to the extraction method, and it is possible that the effect noted is, in some measure, due to this. Otherwise, the physiologic explanation of such an effect is a matter of considerable

difficulty, while a full discussion of the possibilities, at this time, is beyond the scope of the present work. It must, however, remain a matter of record that such decalcification was observed consistently in the series examined, and that it appeared markedly to affect the teeth.

(*4*) *Parathyroid Hormone.*—It has been shown that, in various experimental animals, large doses of parathyroid hormone produce osteoclasis (22) and may even lead to the formation of osteoid tissue (23), thus simulating the osteitis fibrosa cystica of the clinical entity of hyperparathyroidism in man. In this laboratory, however, we have never seen osteoid tissue formation from parathyroid administration in large doses (24). Pugsley (25) showed that, in rats daily injected with parathyroid hormone, calcium excretion was markedly increased during the first four days of treatment, but fell to normal within from 8 to 10 days, despite continued injections. Others also observed that long continued treatment in man, as well as in animals, might lead to reduction of the serum calcium resistance being developed, and Selye (26) demonstrated that this resistance was to be explained by an osteoblastic response in the bone. It was later shown (27) that osteoclasts disappeared from the bone after about from 9 to 12 days of treatment, and that this coincided with the return of calcium excretion and serum calcium to normal levels.

In the crania of rats examined, during the short period of increased calcium excretion, we did not find any significant change; the reason for this may lie in the period of high serum calcium, and increased calcium elimination being short in the rat (which would appear to be an animal relatively resistant to parathyroid treatment). Pugsley (28) was unable to demonstrate a state of negative calcium balance in the rat under parathyroid treatment.

(B) FACTORS PRODUCING EXCESSIVE MINERALIZATION (OSTEOSCLEROSIS)

We have seen, in the normal rat, as the active growth of the cranium decelerates, that there occurs a characteristic, progressive mineralization of the bone, which constitutes the consolidation of the structures grown in youth; this manifests itself as decreasing penetrability to the standard x-ray technic. Always more marked in the male animal, it slowly increases with senility in both male and female.

It is reasonable to suppose that at least the earlier stages of such consolidation is associated with the tapering off of dimensional growth, as full adult size is attained, to which the bone's response to stresses, imposed by full adult muscular activity, doubtless contributes. But such factors cannot be taken in explanation of the continuance of the process into late adult life, and beyond, when the tendency, especially in the male, is toward diminished muscular activity. It must then come to be considered, if not as a degenerative or pathologic process, at least as a manifestation of a diminished physiologic efficiency; it must be regarded much in the same light as the increasing percentage of fat in the carcass with age (29), as a manifestation of an involutional process. That this is normally associated with the level of pituitary function is clear from the work of Lee and Schaffer (30), who found that, on the administration of pituitary growth hormone, the gain in weight of injected over control animals differs very markedly in chemical composition, retaining almost exactly the composition of youth, namely, a higher proportion of water, nitrogen, fat-free dry tissue and ash, and a lesser proportion of fat, despite equality in age and diet of both injected and control animals.

In line with this is our finding that intact rats, treated with a purified growth hormone, tend to show, in the skiagram, less cranial density throughout as well as somewhat larger and more highly developed crania than their controls, so that the radiopacity more resembles that of somewhat younger animals. Pugsley (21-*B*), studying the calcium metabolism of such animals, found that the somatotropic hormone did not alter either the serum calcium level or the calcium balance, whereas in the hy-

pophysectomized rat the effect of this fraction was to restore the calcium balance, previously negative, to normal level. In the untreated hypophysectomized rat, as has already been shown, a relative sclerosis occurs in time, since salts are slowly added to a structure in which resorption is markedly depressed.

The hormones which we have found to exercise an influence in demineralizing the cranium are largely dependent on the functional activity of the anterior pituitary, which specifically stimulates both the thyroid and the adrenal cortex. Whether or not the parathyroid glands also are dependent upon a specific stimulus from this gland would still appear to be in some doubt. Houssay (32) found a cellular atrophy in the parathyroid glands of the dog, following hypophysectomy, although the blood calcium level was not altered, "probably because the parathyroid lesion is partial," but he found that anterior pituitary extract increased the size of the parathyroid glands and their content of clear cells, raising also the serum calcium. This latter, however, does not rise if the dog has been previously parathyroidectomized. Pituitary extracts are without influence on the hypocalcemia and tetany, which follow the operation, and the results following thyro-parathyroidectomy are the same in both the hypophysectomized and normal dog. In pancreatic insufficiency in the dog, in from three to seven days after operation, the blood calcium falls to from 7 to 9 mg. per cent, and once this has taken place insulin is not wholly effective in returning the level to normal or in restoring the histologic structure of the parathyroids.

Houssay found, however, in dogs in whom both hypophysis and pancreas are removed, that the parathyroid lesions, although of the same order as those produced by pancreatectomy alone, were much more severe, a fact which Collip (8) confirmed. As to the latter damage he views it as possibly resulting from nutritive disturbances, associated with the diabetic condition, whereas, in the hypophysectomized-depancreatized animal, he regards the more severe effect as possibly due to the lack of a parathyreotropic hormone, which may or may not be specific. It must be borne in mind, however, that complete proof of the existence of such a hormone is still lacking.

(*1*) *Prolonged Parathyroid Administration.*—It has been shown (24) that long continued administration of parathyroid hormone produces resistance in the injected animal, with improvement in its clinical condition. During this stage osteoclasts disappear; there is a proliferation of numerous osteoblasts with new bone formation. Selye (26-*A*) found that, if treatment is begun with a very small dose, new bone formation may result immediately, without preliminary bone resorption. Such bone deposition is always much more marked in the intact rat. Even in the hypophysectomized animal, formation of new bone takes place, but only after about fourteen days of treatment. Prior to this there is evidence that bone resorption is active. Thus, it would appear that parathyroid extract—or more properly speaking, the resistance developed as a result of prolonged parathyroid treatment—may lead to bone deposition whether the hypophysis is present or not.

In the preliminary investigation of the effect of prolonged parathyroid hormone administration on the rat cranium, samples were taken from a current series of animals that were being injected with two units of "parathormone" twice daily, treatment having commenced on the thirtieth day of life.

The first animal (No. 242-*A*) was examined after 30 days' treatment; the cranial skiagram showed definite "sclerosis," particularly in the tympanic bulla and in the calvaria. This was confirmed by Dr. Selye's independent report from histologic examination of the lower end of the femur.

Another (No. 242-*B*), examined after 45 days' treatment, showed considerably more sclerosis of the skull, affecting most the calvaria and the tympanic bulla; the walls of the incisor teeth were thicker and denser. Histologically, the lower end of

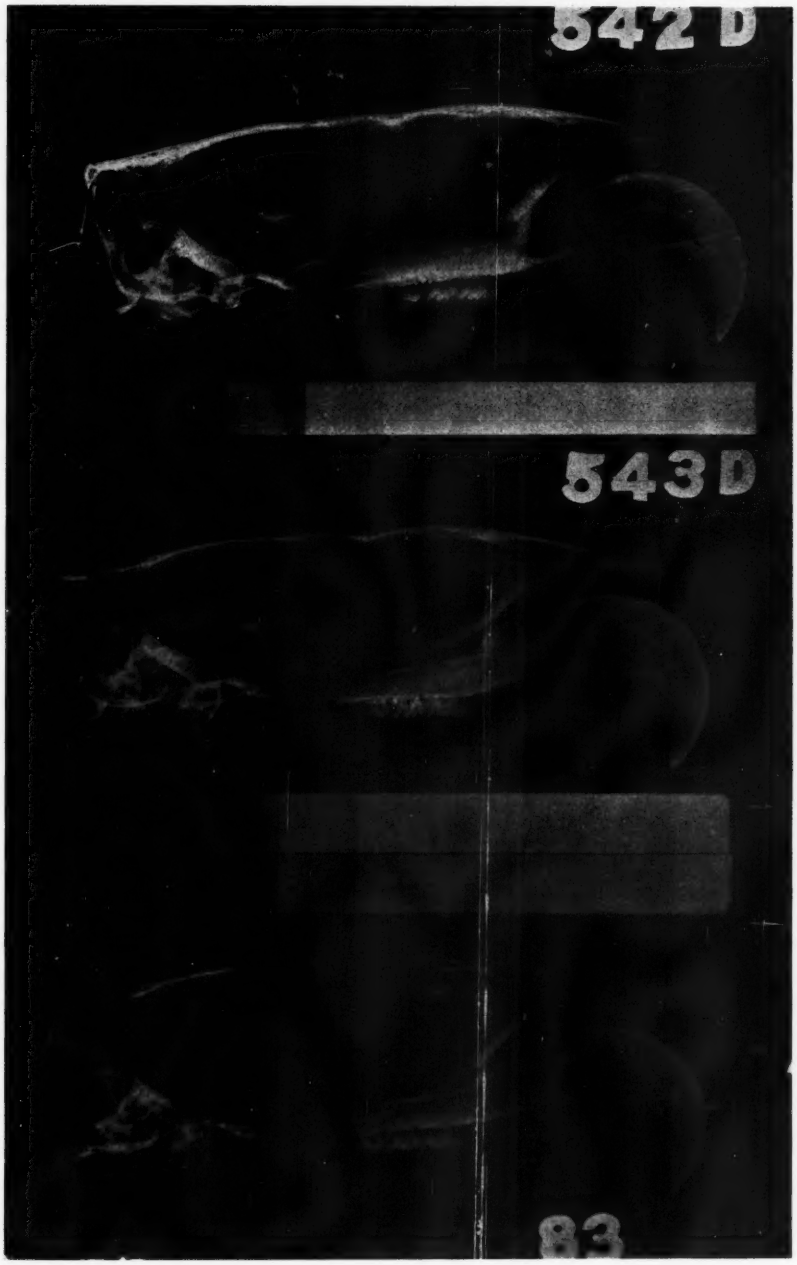


Fig. 16. Effect of prolonged parathyroid hormone treatment and prolonged parathyroid plus thyreotropic hormone treatment on the intact rat cranium.

No. 542-*D*, treated with two units parathyroid hormone, twice daily, for 56 days. Age at death, 86 days; weight, 157 gm.

No. 543-*D*, treated with two units parathyroid hormone plus 0.5 c.c. thyreotropic hormone, twice daily for 86 days. Age at death, 116 days; weight, 154 gm.

No. 83, normal control Age at death, 84 days; weight, 198 gm.

the femur showed the condition described as "marble bone."

A third (No. 242-*D*, Fig. 16), skiagraphed after 56 days' treatment, showed a still more marked cranial sclerosis, particularly outstanding in the tympanic bulla.

None of these animals showed, histologically, any endocrine abnormality, and all these organs were within normal limits in weight.

Three rats were also examined as samples of another series, of the same age as the parathyroid-treated series, and receiving also from the thirtieth day of life the same dose of parathyroid hormone with, in addition, thyreotropic hormone twice daily, in doses of 0.25 c.c. for the first two weeks, thereafter raised to 0.5 c.c. twice daily.

The first (No. 543-*A*) was examined after 27 days of this treatment. The skull was even somewhat less dense than usual, and, for this reason, there was some doubt as to its normality. The tympanic bulla was normal.

The second (No. 543-*B*), examined after 45 days' treatment, showed a cranium unmistakably sclerosed. Histologically, there was independently reported to be "osteoblastic response" in the lower end of the femur. The tympanic bulla was definitely increased in density. It appeared as if the thyreotropic effect was not particularly clearly marked in this cranium, which was almost as dense as that of the animal treated for 45 days with parathyroid hormone alone.

The third sample (No. 543-*D*, Fig. 16) was not examined until after 86 days of treatment with the two hormones. This was found to show only a very slightly greater degree of sclerosis than the cranium of the animal treated for 56 days with parathyroid hormone alone. The tympanic bulla is only moderately affected. The calvarial sclerosis, seen in the skiagram, is confirmed independently by Dr. Selye's histologic report, which describes the condition as "sclerosis of skull." The endocrine glands were normal both histologically and in weight.

The animals of the above two series were on the normal laboratory diet, with a normal calcium-phosphorus ratio. From the confirmation of the radiographic appearances by histologic examination, both of crania and femoral ends, even although the number of animals examined is small, it would appear that, under certain conditions, small doses of parathyroid hormone, administered for relatively long periods, induce a state of resistance to the parathyroid hormone which may be characterized by a general cranial sclerosis, most apparent in the calvaria and tympanic bullæ.

Also, it would appear that the degree of this excessive mineralization is, to some extent, limited by the administration of the thyreotropic fraction of the anterior pituitary, which effect we have shown to be one of demineralization, together with the parathyroid hormone.

Confirmation of the sclerosing effect of long continued parathyroid treatment upon the skull of the rat was obtained in an experiment designed to show the effect of this hormone when given alone, in contrast with its effect, when given simultaneously with a somatotropic pituitary fraction (24). Forty rats, from 40 to 50 days of age, half of which were hypophysectomized just before the experiment was begun, were divided into four groups. The first group received a graded daily dose of parathyroid hormone starting with one unit and increasing by one unit every day until the eighth day, after which they received eight units daily. The second group was treated with 0.5 c.c. of an active purified growth fraction of anterior pituitary. The third group received the same doses of both growth and parathyroid hormone as the first and second groups, while the remainder served as intact and hypophysectomized controls. Each group consisted of the same number of intact and hypophysectomized animals and treatment was begun on the same day in all, namely, on the day after operation of those hypophysectomized. Animals were examined after 8, 18, and 28 days' treatment by histologic section of the lower end of the femur, and the crania were skiagraphed after dissec-

tion. In a certain number of cases the cranium also was examined histologically.

Parathyroid-treated Rats.—In the intact animals the cranial skiagram shows a suggestive increase in density after eight days, at which time the hypophysectomized animals showed no change, and, histologically, there was a mixed osteoclastic and osteoblastic response. After 18 days of treatment, the intact animals showed a well marked sclerosis, while the histologic picture was that of an osteoblastic response, a similar condition being seen after 28 days. In the hypophysectomized animals, the skiagrams showed little change, although the general appearance now showed that the animals had been hypophysectomized. After 28 days of treatment, commencing sclerosis was apparent and, histologically, there was an osteoblastic response in the skull as well as in the femur. It would appear that sclerosis in response to this treatment occurs not only in the intact, but also, although more slowly and to a less degree, in the hypophysectomized rat.

Somatotropic-treated Rats.—After eight days of treatment the intact animals could not be distinguished in the skiagram from the controls. After 18 days there was apparent "growth effect" in the calvaria and in the frontal sinus homologues. Histologically, the long bones of these animals were described as normal. In the somatotropic-treated, hypophysectomized animals, even eight days after operation there was evidence of growth when compared with their hypophysectomized controls. This was still more clearly marked after 18 and 28 days of treatment. The histologic picture in the long bone was described as "porotic." Comparing the hypophysectomized and the intact animals in this group, treated with "growth" hormone, it was evident from the cranial skiagrams that the response was not only more clearly seen, but relatively greater in those hypophysectomized.

Animals Treated with Both Parathyroid and Somatotropic Hormone.—In the intact animals, after eight days of treatment, no distinguishable change could be seen. After 18 days there was both a growth hormone effect and a doubtful increase in density; after 28 days, while the growth influence was still apparent, density was more clearly increased. At both these stages, "marble bone" was reported in the femora. In the hypophysectomized animal there was no evidence of any sclerosis until after 28 days of treatment, while the influence of the growth hormone could be seen from 14 days onward and in certain cases at eight days. Histologically, there was an "osteoblastic response" from eight days of treatment onward. It would appear that the effect of parathyroid hormone, when given with growth hormone, is less marked in both the intact and hypophysectomized animal, than when given alone. In the earlier killed animals the growth effect is more clearly in evidence, the cranial sclerosis occurring only later, and being considerably less in the hypophysectomized animal than in the intact. In both, it would seem to be less than in similar animals treated for an equal length of time with parathyroid hormone alone.

(*2*) *Prolonged Treatment with Crude Alkaline Extracts of Anterior Pituitary.*—It has been found, in certain cases of dogs treated with relatively crude alkaline extracts of the anterior pituitary, that, apart from growth, glycosuria or obesity may result (32). Rats so treated show increased acetone bodies in the blood (33), and large quantities are excreted in the urine in the fasting animal (34). The mode of production of such diabetogenic and ketogenic effects is not known. While it has been held that the fat metabolism hormone is an entity, separate from the growth, thyreotropic, and gonadotropic principles (35), it has to be kept in mind that the diabetogenic and ketogenic principles may be one and the same, and indeed that they may well be merely special physiologic effects of one, or even more than one, of the known anterior pituitary hormones (8).

Our interest in this question arises from our observation of the high frequency of calvarial sclerosis in women who show well marked obesity, and the opportunity arose

of examining the crania, both during life and postmortem, of the rats used by the late Dr. Peter Black in the investigation of hormones experimentally producing ketosis.

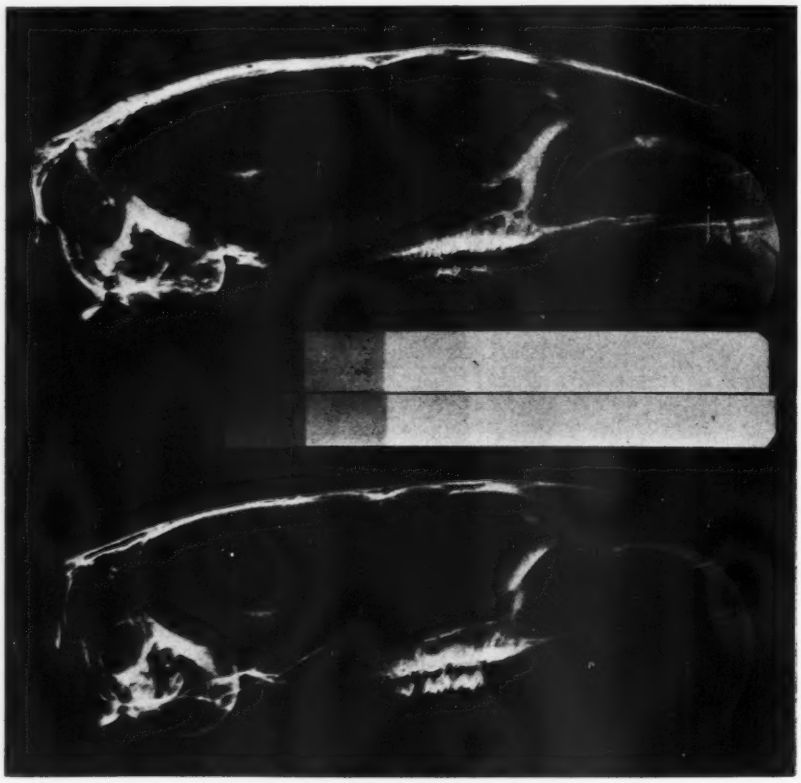


Fig. 17. See caption on opposite page.

In his series we examined 13 animals treated for various periods with Burn's modification of Evans' extract, in which 1 c.c. represented a fifth of a gram of ox anterior lobe; the dose ranged from 0.25 to 2 c.c. twice a day, given intraperitoneally.

Six of the animals were intact males, treated from the sixty-eighth day of life with doses beginning with 0.5 c.c. and rising, as the urinary ketone output tended to fall, tested while fasting to 2 c.c. twice a day, treatment lasting for 77 days and the cranial skiagram being taken of the living animal on the one hundred forty-fifth day of life. Two of these showed absolutely normal crania, in three the density was questionably greater than normal, while in only one was there a condition which one could regard as abnormally dense. It is interesting to note that this animal showed a body weight at the end of the experiment well above normal, and obesity.

Three younger intact females were treated for 100 days, beginning at the thirty-fifth day of life, with, however, a lesser dose, the increase being to 1 c.c., twice a day; as resistance to the ketogenic effect became apparent, two of these showed a doubtful sclerosis compared with control material, and one showed no change at all.

Four hypophysectomized rats, three males and one female, were treated for periods of from 120 to 159 days. Operation

was performed on the eightieth day of life in the three males; treatment began 10 days later, the dose ranging from 0.25 to 2 c.c. twice a day. The gain in weight which resulted from this treatment was very markedly greater than in the intact animals. The crania showed most obvious sclerosis, especially in the calvaria. This seemed to be, to some extent, in proportion to the gain in body weight; obesity in these rats was well marked. In the case of the female hypophysectomized animal, treatment was given for a month prior to hypophysectomy and continued for three months after operation. While in the intact rats the skiagrams show no great change in cranial density, a very marked increase was apparent in thickness and in density of the calvaria before the treatment ended; this was confirmed by the skiagram taken after dissection.

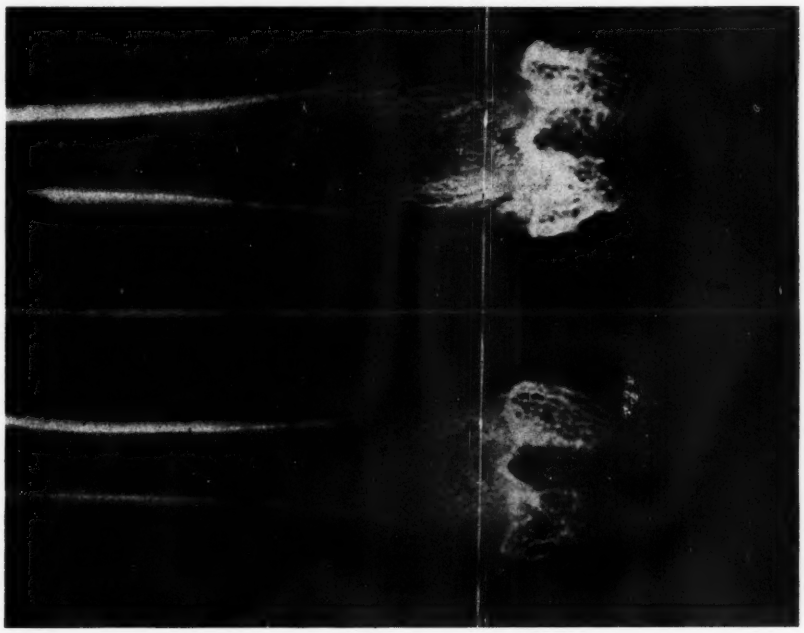


Fig. 17. Effects occurring with resistance induced by prolonged treatment with crude alkaline extract of anterior lobe, in hypophysectomized rat.
"A" and "C," cranium and lower end of femur of a hypophysectomized, treated, animal. Treatment, 120 days. Female, age 196 days; weight, 353 gm.
"B" and "D," cranium and femur of female litter-mate control. Age, 196 days; weight, 163 gm.

It will be seen from this (Fig. 17) that growth has chiefly taken place in the braincase. The increase in both density and thickness of the calvaria is striking, and the effects of hypophysectomy are largely recovered from, except that the snout has lagged somewhat in forward growth. The incisor tooth has almost recovered, especially in its proximal third, although in the distal half there is still evidence, in the thickening of the anterior wall and consequent restriction of the pulp cavity, that this animal had been hypophysectomized. Also, the general form of the tooth is not normal; its semicircular form, instead of being somewhat closed at the extremities, as occurs after hypophysectomy, is opened out so that the chord of its arc would appear to be longer, and not shorter, than normal.

One feels justified in concluding that in

the intact animal prolonged treatment with a crude alkaline, anterior pituitary extract can lead to a dimensional overgrowth, with a tendency to obesity and a fall in the ketone output, in the urine, when the animal is fasted, due to a state of resistance, but that the cranium is only very slightly affected, if at all. The slight increase in density observed may be accounted for by the fact that the animal has merely a stouter bony structure, entirely compatible with the general growth effect.

In animals treated after hypophysectomy, however, it would appear that growth is abnormal, both in amount and in mode. A female rat (Table II) was treated for one month prior to hypophysectomy, and treatment continued for three months after operation, which was performed on the seventy-sixth day of life. At death, when 196 days old, it weighed 353 grams against 163 grams, the weight of a litter-mate control of the same sex whose cranium is also shown (Fig. 17). Table II, in which their cranial measurements are compared, brings out the nature of the change. The treated animal's skull is 10 per cent longer than the control's, and this would appear mostly to be due to excessive growth of the brain-case, which is almost 15 per cent longer than in the control. The nasal bone lengths, however, show only a difference of 3 per cent, a fact of probably slight significance.

As in the cranial growth of the animal hypophysectomized at a very early age, cranial height and width would appear to retain normal measurements, the disproportion, in brain-case growth—in this case on the side of excess—affecting chiefly the anteroposterior dimension. The nasal bone length, while slightly in excess of normal, when compared with the control, is deficient when taken relative to the length of the brain-case, in which respect it may be regarded as still retaining the defective proportion of the hypophysectomized animal. The adoption of this view is aided by the evident retardation in incisor tooth eruption which, above, is 19 per cent less in length, the lower tooth not suffering so markedly. Further indication of serious disturbance in harmonious, proportionate growth, in the snout itself, is evident in the fact that, despite the inadequately erupted teeth, there has been more than adequate forward growth of the jaws, between the incisor and molar teeth, indicated by a 7 or 8 per cent greater length in the diastemata in the treated animal.

Cranial capacity has been increased "passively," it is suggested, to meet the needs of a brain which has shared in a general overgrowth of soft tissues, as a result of treatment, but "active" differential growth in the snout, in line with this, has not taken place, and there is an associated failure in tooth growth and eruption, which possibly may stand in an effect relationship to this failure. The sclerosis may be due not only to an absolutely increased acquisition of salts in the bone tis-

TABLE II.—CRANIAL DIMENSIONS OF HYPOPHYSECTOMIZED RATS AFTER PROLONGED TREATMENT WITH KETOGENIC HORMONE (BURN'S EXTRACT) COMPARED WITH LITTER-MATE CONTROL OF SAME SEX

	Control	Treated	Difference Percentage
1. Total cranial length	44 mm.	48.5 mm.	10.2% Plus
2. Fronto-occipital length	27	31	14.8 Plus
3. Nasal bone length	17	17.5	3 Plus
4. Cranial height	11	11.25	2 Plus
5. Cranial width	15	15	...
6. Upper incisor length (extra-alveolar)	8	6.5	18.8% Less
7. Lower incisor (extra-alveolar)	12	11	8.4 Less
8. Upper diastema	12	13	8.3% Plus
9. Lower diastema	7	7.5	7 Plus
10. Cranial weight	1.8276 gm.	2.4876 gm.	36 % Plus
11. Body weight	163 gm.	353 gm.	116.5% Plus

Total cranial length is arrived at by adding nasal bone length to fronto-occipital length, in order to eliminate the error produced by the difference of the frontonasal angles, in measuring naso-occipital length with calipers.

sue, but also, and perhaps more especially, to a relative increase, in turn due to failure of the process of resorption to keep pace with deposition. It is felt that this may be an important factor in retardation of tooth eruption, the teeth becoming "incarcerated."

The failure of this process of resorption, consequent upon the absence of the anterior pituitary, deprives the mechanism of growth of the most essential factor concerned in that form of harmonious change and adjustment that is called "modelling." Animal stocks, which for long have been both carefully bred and protected in their environment, increasingly show a perfection of morphologic structure and proportion. A good example of this is seen in the so-called "thoroughbred" horse in which the head is finely modelled and clean-cut. This same quality is even more outstanding in the bones of the extremities, which structurally are as light as is compatible with strength. This lightness in growth is achieved by modelling, the design of the bone becoming progressively efficient, mechanically, as the stock is improved. It is to be observed that the same factors are at work in man, although neither his breeding nor nurture are so carefully controlled.

Coarsening of the model is a significant feature in stock deterioration, and while it is undoubtedly true that there are many factors that may produce such change, it would appear that even within the lifetime of one individual the relatively normal form of the model cannot be retained in the absence of the anterior lobe of the pituitary, in spite of the fact that substitution therapy is given in an extract which would appear to contain the complete hormone content of the anterior lobe.

Comparison of the skiagrams of the lower femoral ends (Fig. 17) shows clearly the defect in modelling in the hypophysectomized, treated animal. The end of the bone is not only larger and denser, but it is coarse and club-shaped and has lost its gently sweeping curves. That it is resorption that has mainly failed is apparent not only from the excessive calcification throughout, but also from the relatively greater quantity of dense cancellous bone in the lower end of the diaphysis.

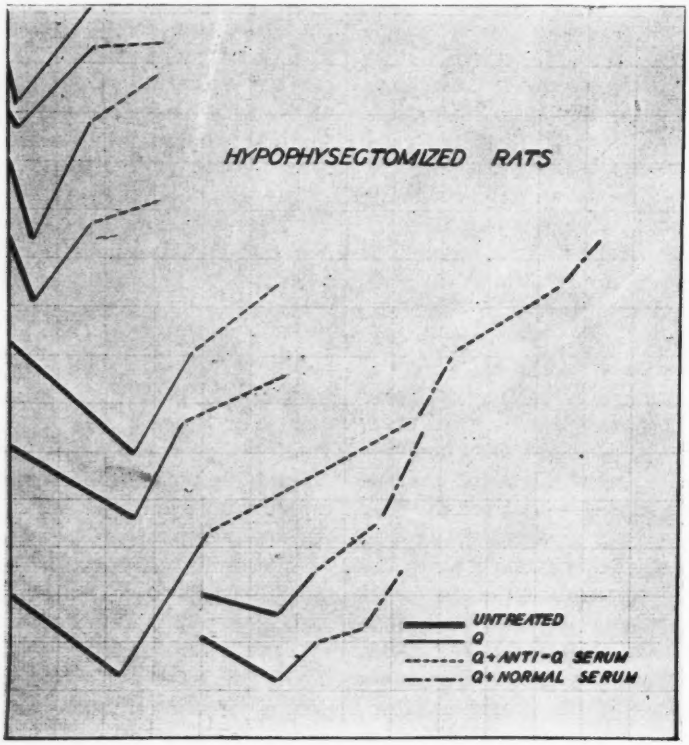
The most marked difference in the two animals is in body weight, the treated being 116 per cent heavier. Autopsy showed that this was in great part to be accounted for by a heavy fat deposit which, although generalized, was most marked on the abdominal wall and in the retroperitoneal tissue.

(*3*) *Prolonged Treatment with Purified Somatotropic Hormone, when Resistance is Delayed.*—When a hypophysectomized rat is treated with a crude alkaline extract of anterior lobe, there may follow an interval of a few days before any appreciable growth occurs. This is due to the presence of thyreotropic hormone in such extracts, the influence of which Collip (8) suggests is to offset the growth effect by increasing the metabolism. On administering a purified somatotropic hormone, however, to a hypophysectomized animal, growth is immediate and may average about from two to three grams a day. With continued treatment this rate of increase can be sustained for from 30 to 35 days, when the growth curve will show a plateau effect. Thereafter, despite continued treatment, loss of weight will be evident, the animal having become resistant to the treatment.

In the case of one hypophysectomized male rat, however, growth was continuous for 77 days of treatment. This occurred in an investigation of the possibility of there being formed, in the course of prolonged somatotropic treatment, a specific "anti-growth" hormone. A horse had been rendered presumably resistant to this hormone by daily injection of "Q 40 A" (purified somatotropic hormone) over a period of four months, receiving in all the equivalent of 6 kilograms of ox anterior lobe. Its serum was investigated to see whether it would inhibit the effect of a somatotropic hormone of known potency, in hypophysectomized rats. Nine male rats, hypophysectomized on the seventy-second day of life, were treated with "Q 79 F" from the thirteenth day after operation. After nine

days of such treatment they were given in addition at first 0.5 c.c. and later 2 c.c. of the horse serum together with the hormone.

Nine days after hypophysectomy (Graph 1), when the animal had lost 17 grams in weight, injection of purified somatotropic



Graph 1. Survivor is No. 559-*A*.

Unfortunately, infection resulted in death of eight animals in relatively early stages of the experiment, rat No. 559-*A*, Figure 18, being the only one to survive an adequate length of time. Equally unfortunately, it has not been possible to repeat this work owing to lack of horses as a source of serum, but it is felt that report, even of this solitary case, is justified by the markedly atypical changes occurring in the cranial structure, as the result of prolonged treatment with somatotropic hormone, and because of the apparent inhibiting effect, together with postponement of the production of resistance, associated with the periodic administration of a resistant serum with the hormone.

hormone was begun and continued for nine days. During this period, the average gain in weight was three grams daily, from the start, demonstrating hormone potency. For the next 26 days the same dose of hormone was given, first with 0.5 c.c. and later with 2 c.c. of treated horse serum; during this time the growth increment fell to 1.1 gm. per day. For the next five days the same dose of hormone with 2 c.c. of normal horse serum was given daily, and the weight gain immediately rose to 2.6 gm. daily. At the end of this time, the growth hormone being continued, normal serum was replaced by 2 c.c. of the treated horse serum for 12 days, during which the daily gain fell anew to just over one gram. On

the substitution of normal for treated serum, growth hormone being continued, the animal did continue to gain for a further 25 days, but only at the rate of 0.5 gm. per day. Thus resistance did not appear until after 77 days of treatment, subsequent to which the animal lost six grams before it was sacrificed.

Postmortem, the body was lean, the thyroid, thymus, adrenals, testes, epididymis, seminal vesicles, and prostate were underweight and atrophic; hypophysectomy had been complete.

The cranial skiagram is of considerable interest in that it bears very close resemblance to that of hypophysectomized rats, treated to the resistance point with a crude alkaline extract, and no resemblance to any of the 20 hypophysectomized, Q-treated rats, studied radiographically. It is the only one treated with this hormone that shows sclerosis. All the others show what we have come to recognize as a characteristic "Q"-hormone effect, namely, expansion of cancellous bone, particularly the diploe. This is best seen in hypophysectomized animals after about one month of treatment. Somatotropic treatment, continued beyond the resistance stage (for periods of from 100 to 120 days), does not produce further growth, and sclerosis has never been observed. As already stated, in the hypophysectomized animal that has responded well to "Q"-hormone, the bone structure is somewhat less dense than normal, and in fact, in animals treated for periods beyond the resistance point, the bones may be so frail as to break in stripping the cranium of its soft tissues. In this rat the Q-effect is clearly seen in the interparietal bone, whose diploe, however, is not sclerosed. Elsewhere in the diploe, the outer and inner tables are separated by a sclerosed middle table. The frontal sinus homologue is larger than in hypophysectomized animals, treated to the resistance point with alkaline extract. The tympanic bulla is dense; recovery has been excellent in the bones of the cranial base. The molar and incisor teeth have benefited: in the latter the form is almost normal—semicircular in outline, with just a little flattening of the anterior tooth surface at the junction of the anterior and middle thirds. The anterior wall, however, is abnormally thick and dense and the pulp cavity definitely restricted in size.

The similarity of this cranial condition in a lean animal, which despite growth is underweight for its age, to that found in rats made resistant to the ketogenic effect of alkaline extracts, in which adiposity is apt to be a feature, may be significant.

Study of the general growth process reveals the fact that it is discontinuous; that even in the period of greatest activity in youth it flows and ebbs, and there are indications that in the hormonal mechanisms, which largely control it, there is a periodicity the phases of which, of phylogenetic acquisition, carry in their activity their own decline, somewhat in the sense, although not necessarily by the mechanism, by which the products of fermentation in wine eventually inhibit the activity of the yeasts that are their source. Such balanced functional pendulum-like devices are frequent in Nature; stimulation of the respiratory center by CO_2, the apnoea that follows the "*Auspumpung*" effect of pulmonary hyperventilation, are common examples of the many that might be cited. They are compensatory in their function and have the inherent weakness of compensatory adjustments, that they may over-swing—to cite but one example, the fall in blood sugar that may follow ingestion of a large carbohydrate meal.

It seems not unreasonable to view the production of sclerosis in growing bone, bone indeed overgrown for a time in certain directions, from the prolonged dosage with growth hormones, as due to over-emphasis of the phase of consolidation and induced by over-swing in the first phase. That following prolonged exhibition of parathyroid hormone, the short term effect of which is to demineralize bone, may be similarly regarded, and the possibility immediately arises that the former may actually be produced by the mechanism of the latter, thus forming still one other ba-

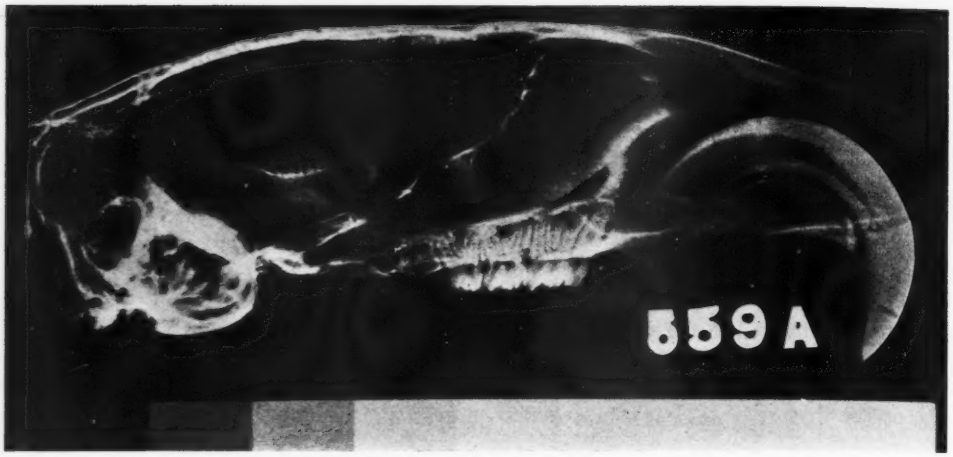


Fig. 18. Cranial sclerosis from prolonged administration of purified somatotropic hormone "Q" plus anti-"Q" serum.

sis of presumption of the actuality of an anterior hypophyseal parathyreotropic hormone.

SUMMARY

(1) A roentgenologic study has been made of the rat cranium throughout normal growth. In growth and differentiation it is comparable to what is known to take place in man, hence conclusions derived from this work may reasonably be used to aid in understanding human cranial dysplasia.

(2) Attention is drawn to the intrinsic functional significance of the frontal sinus-homologue and the "supra-ciliary" canal in the rat, during growth and more especially in differentiation. The changes observed in this area, both after hypophysectomy and with treatment, throw light upon certain human anatomical growth variations, seen in clinical radiologic work, in man, not only in the frontal but in the other accessory sinuses as well.

(3) Complete removal of the hypophysis at an early age, in the rat, markedly retards cranial growth, especially in its differentiation. The resulting deformities form a syndrome which, although its components can be produced by other and non-specific causes, is, *in toto*, characteristic of this loss. The resultant roentgenologic appearance has come to be, in this laboratory, in the course of two years, a reliable criterion of judgment of the completeness of hypophysectomy and the adequacy of substitution therapy. The characteristic appearances have been recognized, in the cranial skiagram, as early as the eighteenth day after operation.

(4) The defects resulting from hypophysectomy are:

(*A*) A marked decrease in vascularity of bone, affecting individual bones in proportion to the abundance of their normal vascular supply, and to the degree and pattern of differentiation that they normally are called upon to undergo in growth.

(*B*) As a result, the processes of *pari passu* resorption and deposition are seriously disturbed, the former apparently being more affected than the latter.

(*C*) All growth does not cease: cranial height and width reach materially normal dimensions; anteroposterior growth suffers.

(*D*) The snout is more affected than the brain-case; growth is inadequate in all directions.

(*E*) A roentgenologic diagnosis of completeness of the operation can be rapidly and reliably arrived at from the following observations: the cranium is small for the age and sex of the animal; the snout is disproportionately small relative to the brain-case. The calvarial outline corresponds, *in form*, to about the age at which the animal was hypophysectomized, although the dimensions may have increased. The middle table in the calvaria is hypoplastic, and in consequence presents the appearance of being obliterated, especially in the parietal bone. The frontal sinus-homologue is hypoplastic. The characteristic tooth changes described by Schour and van Dyke are seen.

(5) Similar defects result from hypophysectomy in the dog's cranium where there is arrested growth of a true frontal sinus.

(6) Incomplete dimensional recovery from these post-operative defects has been produced experimentally by treatment with "growth" hormones. The crania of 21 hypophysectomized animals, treated with somatotropic (purified growth) hormone, were examined. This fraction seems to have a specific effect on the vascularity of bone, restoring the normal architectural structure to the diploe, frontal sinus homologue, and cancellous bone throughout the cranium. There results, apparently, satisfactory growth and differentiation in the snout, the incisor tooth showing a normal x-ray appearance in the part grown since treatment. The beneficial effect would seem to be best marked after from 30 to 40 days' treatment, if this is instituted within a reasonable period after operation. Unfortunately, treatment beyond this point has led so far to a resistance, which Collip has suggested may be due to the formation of a specific anti-hormone. Such "Q" fractions cause a relative reduction of density in the reactivated bone which, it is suggested, may serve to aid the "expansion" of the growing structures or, more likely, the appearance may be due to this process being active. Prolonged use of this hormone, in the hypophysectomized animal, is associated with a clear-cut decalcification and cessation of growth. It is not suggested that this defect is specific. In one hypophysectomized animal, in which the onset of resistance was delayed to almost double the normal time of onset, growth continued and the opposite effect—sclerosis—occurred.

(7) With crude alkaline growth extract, in the hypophysectomized animal, resistance was considerably longer in appearing and a greater increase in body weight occurred, but the animals were considerably more obese than those treated with "Q" fractions. Incomplete recovery occurred in the snout and teeth, while well marked overgrowth, in the anteroposterior direction, appeared in the brain-case, together with a well marked sclerosis. The impression was gained that treatment with the purified fraction produced growth that was absolutely less than with the crude extract, but that the modelling of the resultant bone was more nearly normal, and that, in general, differentiation in the snout was better. The crude alkaline extracts produced overgrown bone of a coarse, heavy, poorly differentiated type.

(8) In the intact animal, thyroid by mouth and thyreotropic hormone led to demineralization recognizable in the skiagram and affecting both bone and teeth. Prolonged administration of adrenotropic hormone produced similar results in young adult rats, but there is doubt as to the specificity of this last effect.

(9) Cranial sclerosis, best seen in the calvaria, frontonasal angle and tympanic bulla, was observed in intact animals treated with prolonged parathyroid hormone dosage, and in others, similarly treated, there was evidence that simultaneous administration of a thyreotropic fraction did, to some extent, inhibit this effect, as did also purified somatotropic hormone. In hypophysectomized animals, under such treatment, it appeared that a similar result

will follow, to a less marked degree, and that a much longer period of treatment is necessary to produce it than in the intact animal. Histologic study of animals in this group confirm the x-ray findings. The factors involved in such results are by no means clear, but it is felt that both diet and calcium-phosphorus ratio are implicated.

(10) Sclerosis was also produced by the prolonged administration of crude alkaline anterior lobe extracts. Slight in degree or lacking in the intact animal, marked sclerosis occurred in the hypophysectomized rat as resistance developed, especially as the animal became resistant to the ketogenic effect of such hormones, and this sclerosis was associated with obesity. This throws light upon the cranial sclerosis frequently to be found in obese women.

(11) One case is discussed in which sclerosis resulted from the prolonged administration of a purified somatotropic hormone, under very special circumstances.

These investigations, of which the above is but a preliminary statement, were undertaken to throw light on the complex problems arising from the work done with Levene and Rowe prior to 1933 on human cranial dysplasia. They were made possible by the kind co-operation of Professor Collip, who has placed at my disposal for the furtherance of this study the facilities of his department. I wish to thank Professor Collip and his colleagues, Professor D. L. Thomson, Dr. Hans Selye, Dr. L. I. Pugsley, and Dr. R. L. Kutz, who by their generous co-operation have made this research possible.

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SERIAL ROENTGEN EXAMINATIONS OF THE CHEST IN UNIVERSITY STUDENTS[1]

RESULTS OF SINGLE FILM STUDIES IN STUDENTS WITH POSITIVE MANTOUX REACTION

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SERIAL roentgen examination of certain groups as, for instance, school children (1), young working people (2), food handlers (3), students (4), state police, soldiers, and sailors (5), have been carried out during the last few years by investigators in a number of countries. In the United States the studies of Hetherington (6) and his co-workers are known to all interested in this subject. One of the most important results of these investigations is the fact that a small percentage of active tuberculous lesions will be found which cannot be detected by physical examination but can be discovered by the roentgen ray. Stimulated by the reports published, a program of roentgen serial examinations among the new students entering the University of Wisconsin was outlined and carried out; we are giving in the following a brief résumé of the results.

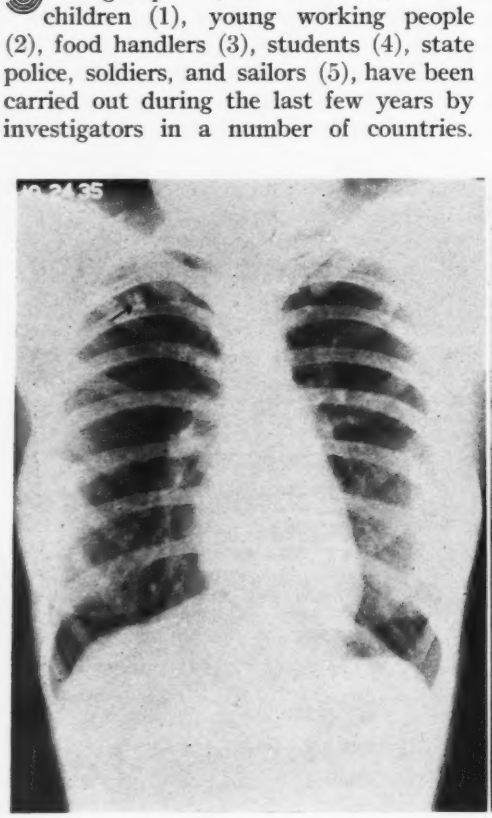

Fig. 1. Fig. 2.

Fig. 1. Adult type of tuberculosis in lung parenchyma.
Fig. 2. Apical pleuritis.

METHOD

In view of the relatively high cost of film studies the fluoroscopic method was considered first. While acceptable to some of the clinicians, the Department of Radiology opposed this way of approach

[1] Presented before the Radiological Society of North America, at the Twenty-second Annual Meeting, at Cincinnati, Nov. 30–Dec. 4, 1936.

TABLE I

	1	2	3	4	5	6	7	8	9	10	11	12
1. Do you believe that beginning TB. lesions in the lungs can be detected by fluoroscopic study as early as by good roentgenograms of the chest, either flat or stereoscopic?	No	No	No. Daily experience disproves such assumption	No. Flat films usually suffice	Absolutely not	No	No	No	No	No	Possible in most cases	No
2. Do you believe that among those cases found negative on fluoroscopic examination there are some that would show small lesions if examined by flat or stereoscopic roentgenograms of the chest?	Yes	Yes, I certainly do	Yes, quite certainly	Yes	Certainly	Yes	Yes	Yes, many	Yes	Yes	Yes, but only small number	Yes
3. If your answer to Question 2 is in the affirmative, could you give me an approximate percentage of small lesions which may be overlooked by fluoroscopic examination only?	No	No percentage, sure to be appreciable	Practically *all* small lesions will be overlooked fluoroscopically	Depends on observer. However, "the earliest lesions are not even shown by *excellent* films"	At least 50 per cent of early lesions	No data available	No percentage given	25 per cent	?	?	?	?
4. Does fluoroscopic examination in your opinion constitute a satisfactory and reliable method for progress studies in early cases of tuberculosis of the lungs, diagnosed by roentgenogram?	No	No, absolutely not	No	It does not	No	No	Yes, provided films are taken frequently	No, for small lesions; yes, for large lesions	No	"I would never exclude active lesions by fluoroscopy alone"	Cannot answer to purpose in all cases	*No.* This is admitted by all competent workers

Additional Remarks Appended to Some of the Questionnaires.—"There is nothing more dangerous or misleading than reliance upon a fluoroscope for diagnosis of early tuberculous lesions. It misses just the cases that are most amenable to treatment"; "Single films usually suffice. It is absurd to expect fluoroscopy to give the detail that one gets from a good film. Paper is not practical"; "A man would have to have a wonderful memory to be able to say that a 'faint shadow' is more faint or less faint now than it was 6 months or a year ago. To depend upon the fluoroscope for the diagnosis and follow-up of early TB. or any phase of TB., would be to turn back to the days before radiographs were made. No roentgenologist would do it, and any other physician who did should not be permitted to practise medicine"; "It is simply optically and physically impossible for the fluoroscope to detect changes of densities as accurately as can be done by the film. *A fortiori*, the fluoroscope is utterly inadequate for the supervision of tuberculous infiltrations, both because it is not exact enough and because a permanent record is essential for accurate comparison of the lesion from time to time."

because we were and still are convinced of the superiority of the roentgenogram for the detection of small lesions even if single films had to be used. As will be shown later we found ourselves in full accord with leading radiologists in this country. It is true that Reid (7) advocates the fluoroscopic examination for this purpose, based on 1,035 cases with a mistaken diagnosis in only two instances; the number of detected cases of tuberculosis is not given. However, Hetherington, *et al.* (8) point out a number of shortcomings of the fluoroscopic examination. It not only fails to reveal a considerable part of the calcified nodules and lymph nodes visible in roentgenograms, but rarely shows a tuberculous infiltration located at the apex of the lung above the clavicle. Schaare (9) reached similar conclusions. He compared the results of the examinations in 400 cases obtained by the fluoroscope and the roentgenogram; in 17.85 per cent the fluoroscope did not detect the lesion and in 21.75 per cent a lesion was suspected but could not be definitely classified. Licht (10), who surveyed the literature on this subject and conducted tests of his own, believes that "the explanation of the screening errors must lie in reduction of the dark vision; the reduced power of distinction, especially, playing an important part, while the reduction of the visual power plays only a minor rôle." In his opinion "the best method for lung examination is roentgenography followed by screening." In order to obtain ad-

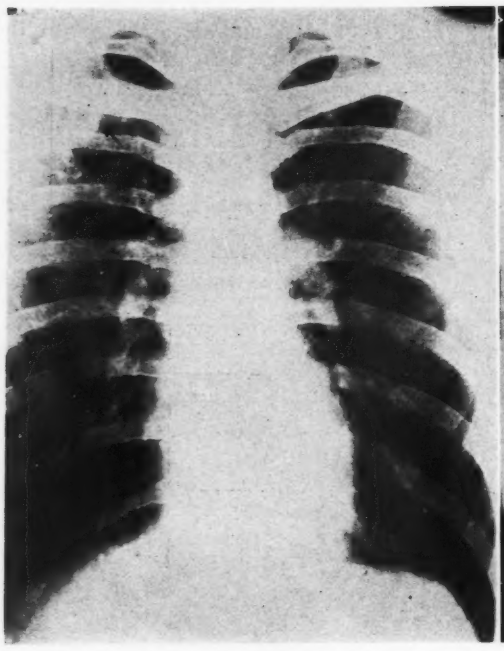

Fig. 3.

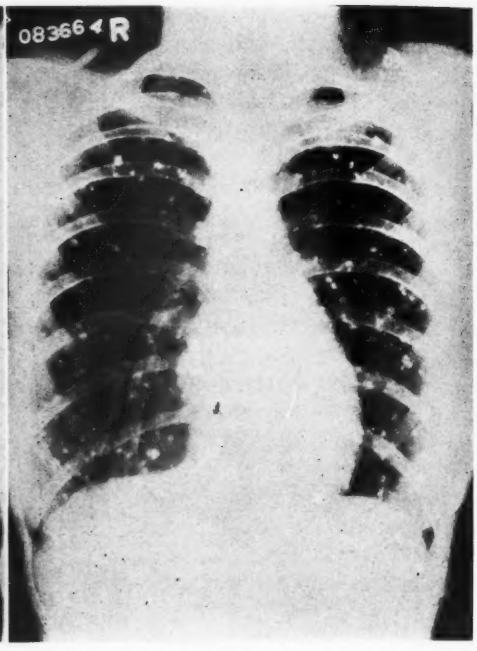

Fig. 4.

Fig. 3. Advanced adult tuberculosis with cavitation.
Fig. 4. Multiple calcified hematogenous foci.

ditional information we sent a questionnaire to 12 recognized radiologists selected throughout various parts of the country. The questions and answers are shown in Table I; they speak for themselves.

Supported by this overwhelming expression of opinion in favor of the film method, the necessary funds were procured to finance the single film examination. Paper films were not considered because they do not show sufficiently fine detail necessary for the recognition of minimal tuberculous lesions (see also editorial in the December, 1934, issue of RADIOLOGY, **21,** page 591).

Since approximately from 2,000 to 2,500 new students enter the University each fall, and since the present physical plant could not handle such a number efficiently, the staff of the Student Health Service proposed to give all new students a Mantoux test and refer all positive reactors for roentgen examination. A study of the literature seems to indicate that a positive tuberculin reaction is to be regarded as a sign of tuberculous infection either active or inactive (11 and 12).

TECHNICAL PROCEDURE

Since the examination of such a large number of individuals would add a considerable burden to a busy department, a method was worked out whereby these examinations could be done in a minimum of time and without interfering too much with the routine work.

Groups of approximately 100 students were examined at a time, the work beginning immediately after regular hours. Men and women were taken in separate groups. All clothing was removed to the waist; the women were given paper jackets to wear. The group was formed in line passing by a desk where two persons took care of the handling of records and the preparation of identification numbers. The technical procedures concerned with

the exposing of the films were handled by three persons. One technician positioned the patient before the film holder, measured the thickness of the chest, gave the necessary instructions to the patient, and instructed a second technician handling the controls as to the proper voltage to be used. A third assistant carried the cassettes to and from the dark room. By proper team work it was possible to make an examination approximately every 45 seconds and a group of 100 could be handled in about one hour. In spite of the rapidity with which the examination was done there were only 3 per cent retakes needed due to improper technic. Only one skilled technician was necessary; the rest of the work could be done by less skilled helpers. The loading and unloading of cassettes in the dark room required the services of two persons. Exposed films that could not be developed immediately were stored in light-proof boxes and processed later. The technical factors used were as follows: distance, 72 inches; 150 milliamperes; time of one-tenth second; voltage varied according to the thickness of the chest.

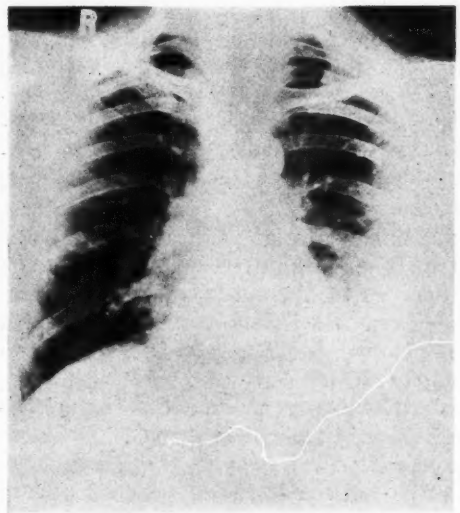

Fig. 5. Metastatic carcinoma in lung parenchyma.

DISCUSSION OF THE RESULTS

The first column in Table II lists the number of cases showing no evidence of tuberculosis. The next three columns give the number of cases showing calcification, either in the lung parenchyma (Ghon tubercle), in the hilum lymph nodes, or in both. The presence of such calcification was considered evidence of a previous first infection or childhood type of tuberculosis. The last two columns include the cases showing evidence of the reinfection or adult type of lesion. These were subdivided further into those in which the lesion was in the lung parenchyma (Fig. 1) and those in which the major change appeared to be a thickening of the

TABLE II.—SUMMARY OF X-RAY FINDINGS

Year	Neg.	Ghon	Hilum	Ghon and Hilum	Adult Inf.	Apical Pleur.
1934	507	66	47	33	16	10
1935	752	93	64	51	11	2
1936	813	73	69	75	18	19
Total	2072	232	180	159	45	31
%	76.21	21			2.79	

TABLE III.—X-RAY FINDINGS NOT RELATED TO TUBERCULOSIS

Year	Heart	Anom. Lobes	Anom. Ribs	Pleural Thick.	Chron. Infl.	Bronchiectasis	Rib Res.	Misc.
1934	26	6	17	17				3
1935	48	9	18	32	5	2		2
1936	48	7	14	24	21	1	2	
Total	122	22	49	73	26	3	2	5

apical pleura—apical pleuritis (Fig. 2). No attempt will be made in this discussion to classify these lesions further. Suffice it to say that practically all types of tuberculous lesions were encountered; some unquestionably active and advanced as evidenced by the softness of the shadows and the presence of cavities (Fig. 3), while others were more fibrotic in appearance with evidence of scarring and retraction. The same is true as to the extensiveness of the involvement, the lesions varying from small round or wedge-shaped opacities to involvement of half of both lungs.

On the roentgenogram, the cases classified as apical pleuritis showed a band of increased density over the summit of one or both apices. In order to be of significance the lower margin of this band had to be somewhat rough and irregular and frequently fine trunk markings could be traced up to and merging with it. The significance of such pleural changes may be open to question. It is our opinion that when care is taken to exclude other causes for such a shadow (subclavian vessels, muscle shadows, flared rib margin), such densities are to be considered as evidence of a tuberculous pleuritis and that in this particular age group this finding has more significance than in patients of more advanced age. It is often difficult to decide from a single roentgenogram whether the lesion is limited to the pleura or whether there is involvement of the immediately adjacent lung parenchyma; whether it is a recent inflammatory thickening or an older and fibrotic scar. Progress films at suitable intervals seem indicated especially in many cases of this type.

Two unusual cases representing accidental findings are illustrated in Figures 4 and 5. One is a student with what we consider as multiple calcified hematogenous foci; the other shows a metastatic nodule in the parenchyma from a primary carcinoma in the breast.

Other roentgen findings not related to tuberculosis are listed in Table III. While some of the abnormalities discovered are of scientific interest only (anatomical variations), some have definite clinical significance, as, for instance, bronchiectasis.

SUMMARY AND CONCLUSIONS

(1) During a three-year period (1934–1936) all new students entering the University of Wisconsin were subjected to a Mantoux test by the Student Health Department. The positive reactors were referred to the Department of Radiology for a single roentgenogram of the chest.

(2) The technical procedure is described.

(3) It appeared that 2.79 per cent of the 2,719 students examined showed some adult type of tuberculous lesions, while 21 per cent presented evidence of previous first infection or childhood type of tuberculosis.

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DISCUSSION

Dr. Henry Kennon Dunham (Cincinnati, Ohio): Nothing in prevention of disease is more important than the study which has just been presented. This study is to be encouraged because the death rate from tuberculosis in the adolescent has dropped very little.

It is encouraging to find so many of our colleges and colleagues devoting time, brains, and money to this sane method

of stamping out tuberculosis and saving lives.

The essayist brought up the relative values of the fluoroscope, the value of the paper films, the single films, and the stereoscopic films.

I would like to repeat what I have said a good many times. What you men very well know but which I think you ought to repeat to the doctors in your hospitals. The fluoroscope is primarily valuable to study motion; it does not have the same value when it comes to studying structure. It is very important not to let the doctors think that they can see a great deal of fine structure with the fluoroscope.

The film records this fine structure and is a permanent record. The stereoscope gives a better record of structure and allows the roentgenologist to study the anatomical relation of that structure. The paper film records gross structure only. All of these procedures are good but to be useful they must have intelligent selection.

DR. JAMES JAY CLARK (Atlanta, Ga.): I am very much interested in Dr. Pohle's report and wish to congratulate him on bringing this interesting subject to our attention. In Atlanta, at Emory University, we started this routine examination two years ago and, while we have not examined as large a number as Dr. Pohle reports, we are increasing the group each year and expect in 1938 to have included the entire student body of the University.

At present only the students showing a positive Mantoux test have been studied by x-ray—we use the fluoroscope and follow with stereoscopic films. I should like to emphasize what Dr. Dunham says, namely, that the fluoroscope is principally of value in the study of motion and in these students we obtain very little information from fluoroscopic examinations.

I am looking forward to the next four or five years in following the freshman students who have shown a positive Mantoux test and hope to determine if hilus calcification and Gohn lesions have any particular meaning. Personally, at this time I believe they mean only that the individual has had a previous tuberculous infection.

We have found a few students who had an active tuberculous infection. We have found another group which might be classed as "borderline" and these men are placed under observation and carefully watched.

There is another angle that should have consideration; that is, the effect upon the family and the student when a positive Mantoux test is reported. This test should be carefully explained to the student so that undue worry and fear may not be occasioned. I have seen several students who have had positive tests in other universities brought home to the family for examination by their own physician, who understood that the student had an active infection.

One other point—concerning the fluoroscoping of large groups of students. You will recall that during the war, many soldiers fainted when they were vaccinated against typhoid or smallpox. If you attempt to fluoroscope a group of men, place them so that, if they faint in the dark, they will not injure themselves by striking against sharp corners.

I am sure the next few years will tell us whether or not these tests are worth while. I also believe that the men who do not show a positive Mantoux test should have this same examination, as in a certain percentage of positive infections the Mantoux test is a failure.

DR. WALTER S. LAWRENCE (Memphis, Tenn.): If there should be any doubt in the minds of any of you as to the lack of value in the fluoroscoping of these difficult cases, these fine lesions as it were, just remember the words of Scripture. The Bible mentioned the fluoroscope long years ago. It says somewhere: "A man looketh at himself in a mirror and goeth his way and straightway forgetteth what manner of man he is."

We need the permanent record!

DR. ERNST A. POHLE (closing): I am very glad indeed that Dr. Dunham brought out in his discussion the shortcomings of our method of approach. I am fully in accord with him that all students should be examined by roentgen rays and not only those who had a positive Mantoux test. I do hope that eventually we will get sufficient funds and personnel to carry it out on that basis because there is no doubt that positive cases may be overlooked now.

I very strongly feel that if one were to detect only one case of active tuberculosis in all those students who are not examined roentgenologically, under our present plan the expense would be justified and well worth while.

BILATERAL SPONTANEOUS IDIOPATHIC PNEUMOTHORAX IN APPARENTLY HEALTHY INDIVIDUALS[1]

A REVIEW OF THE RECENT LITERATURE AND PRESENTATION OF A CASE

By FRED A. HASNEY, M.D., *West Orange, N. J., and* FELIX BAUM, M.D., *Newark, N. J.*

THE number of bilateral spontaneous idiopathic pneumothoraces published in the literature is rare, although unilateral cases have been reported in great number. In looking over the latest literature on the subject we found an extremely instructive article published by Rossel (1). Leaving aside all discussion of spontaneous pneumothoraces appearing in connection with certain diseases capable of producing destructive processes of the pleuropulmonary tissue, and pneumothoraces produced by extra- and intra-thoracic trauma, Rossel limits his attention to the "spontaneous pneumothorax which Gaillard has called "pneumothorax des conscrits," pneumothorax which occurs unexpectedly in a healthy individual, which is also called benign idiopathic pneumothorax or simple pneumothorax, or again, but more inappropriately, pneumothorax from strain or accident."

The problem of the etiology and treatment of this condition is of real practical importance, since the pneumothorax called "des conscrits" is not as rare as one thinks, unilateral pneumothorax least of all. Of these latter, Friesdorf, in 1927, estimated that there were 177 published cases. Rossel, from his bibliographic research of ten years, concludes that at the present time this figure can be doubled. Bilateral cases, however, are infinitely more rare. Rossel found 13 cases mentioned by Olbrecht, and, in addition, one of Bedford (1929), one of Ackermann (1931), one of Sorren-

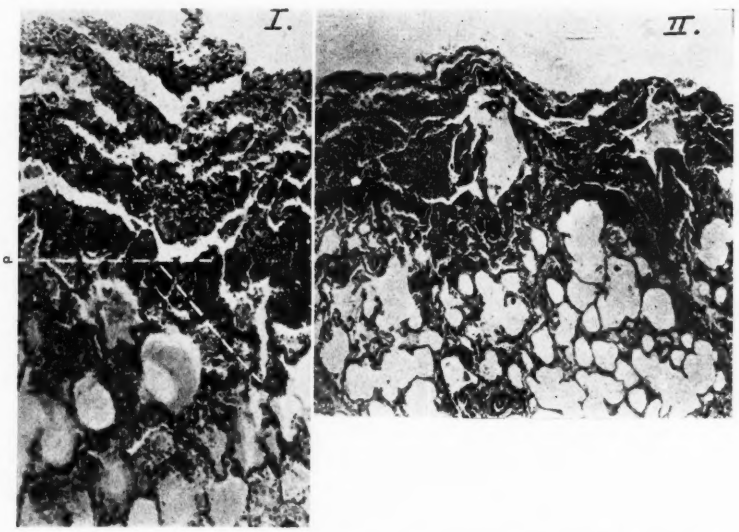

Fig. 1. Air spaces within the visceral pleura. Notice connection with alveoli (*a*).
Fig. 2. The formation of a vesicle in the beginning. (*From Schmincke, Ziegler's Beitr. z. path. Anat., 1928,* **80**, *692. Courtesy of Gustav Fischer, Jena.*)

[1] X-ray Demonstration, Clinical Staff Meeting, St. Mary's Hospital, Orange, N. J., Dec. 10, 1935.

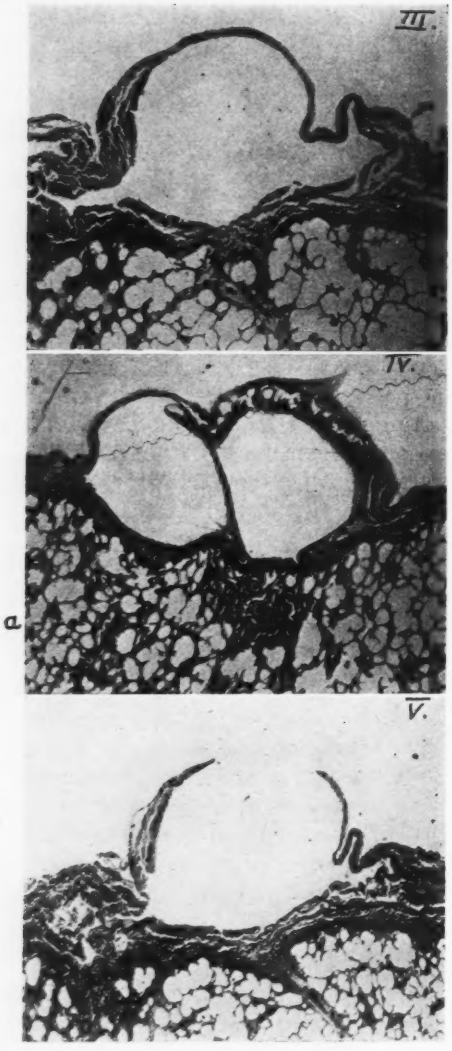

Fig. 3. A vesicle fully developed.

Fig. 4. Two vesicles. Malformation of embryonic lung tissue (*a*) surrounded by normal alveolar tissue. This zone represents an incomplete or inhibited development.

Fig. 5. Ruptured vesicle. (*From Schmincke, Ziegler's Beitr. z. path. Anat., 1928,* **80,** *692. Courtesy of Gustav Fischer, Jena.*)

tino (1931), and, finally, one of Markson and Johnson (1934), making in all 17 cases. To these he adds two under his own personal observation. The first one was that of a boy of 17 without any past history of pulmonary disease. In apparent health, he developed suddenly a spontaneous pneumothorax on the right without fever and without a significant pleural reaction. Rossel continued the collapse artificially. Six months later, in the course of an x-ray examination, while the pneumothorax on the right still existed, he discovered a second very complete spontaneous pneumothorax on the left with almost no pleural reaction. Subjective signs were absent. *The diagnosis was possible by x-ray only.* A thoracoscopy, done ten days later, did not show the place of pulmonary rupture. Instead, it revealed the presence of yellow, subpleural nodules. The pneumothoraces were absorbed progressively and the lungs re-expanded. In Rossel's other case, a young man of 20 without a previous history of pulmonary pathology, two days after his entrance in a school of recruits, developed in the morning after dressing, without preceding effort, a sudden left hemopneumothorax, with intense dyspnea. After aspiration of air and blood transfusion he improved, but five days later, in the morning again, a spontaneous pneumothorax on the other side formed suddenly. Patient died a few minutes later from asphyxia. The autopsy showed on the left a pneumothorax containing 3,500 c.c. of blood and a completely flattened lung. In spite of a very careful search, the pleuropulmonary rupture and the source of the hemorrhage could not be discovered. On cutting the lung, bronchial dilatations, localized at the apex, were found. On histologic examination, dilated subpleural alveoli were noticed. On the right side there was a complete dry pneumothorax, the lung being entirely collapsed against the spinal column. At the apex of the right upper lobe, Rossel found emphysematous subpleural bullæ as big as beans. One of these was ruptured; under water, bubbles of air escaped. There was no tuberculosis on either side.

As to the pathogenesis of this condition, Rossel cites two opposing theories:

(1) That held, among others, by Sergent, of a tuberculous origin;

(2) That held by Gaillard who postu-

Fig. 6. Massive spontaneous collapse of right lung (Oct. 17, 1934).
Fig. 7. Bilateral spontaneous pneumothorax (Nov. 10, 1934). No evidence of active pulmonary tuberculosis.

lates the rupture of an emphysematous vesicle, discarding all ideas of infectious origin. As objection to Sergent's theory, Rossel points out the fact that pneumothorax of the idiopathic type occurs very rarely in sanitoria, that in these cases of idiopathic spontaneous pneumothorax the pleural reaction is generally absent, or if present at all, is insignificant and fleeting, and that there is a tendency to recurrence. Rossel distinguishes two varieties: pneumothorax appearing

(*a*) on both sides at the same time (simultaneous),

(*b*) first on one side and then, after a variable period, on the opposite side (alternating).

He cites a case of the first type, that of a student who, after violent exercise, was carried suffocating from the stadium. *A diagnosis could not be made without an x-ray* which revealed the presence of a bilateral pneumothorax. This patient recovered rapidly after aspiration of air. To explain the bilaterality in this instance, he suggests three hypotheses:

(1) A single and the same cause had effect in the same way both on the left and on the right; the rupture was double because of an identical pathologic state in the two lungs;

(2) The sudden entrance and pressure of air in the pleural cavity caused a rupture of the mediastinum; by the communication thus created, the air passed into the opposite pleural cavity;

(3) The interpleural communication was not traumatic in origin but congenital.

According to the last two possibilities, the pneumothorax would be double but the pleuropulmonary rupture single. Rossel says:

"When the two pneumothoraces occur successively, their formation is evidently independent one from the other: there are two ruptures, one on each side. Is it necessary to postulate for each one a different etiology? We do not think so."

In the first of Rossel's cases, summarized above, the two pneumothoraces, separated by an interval of six months, evolved in an absolutely identical manner. The thoracoscopic examination of the left side

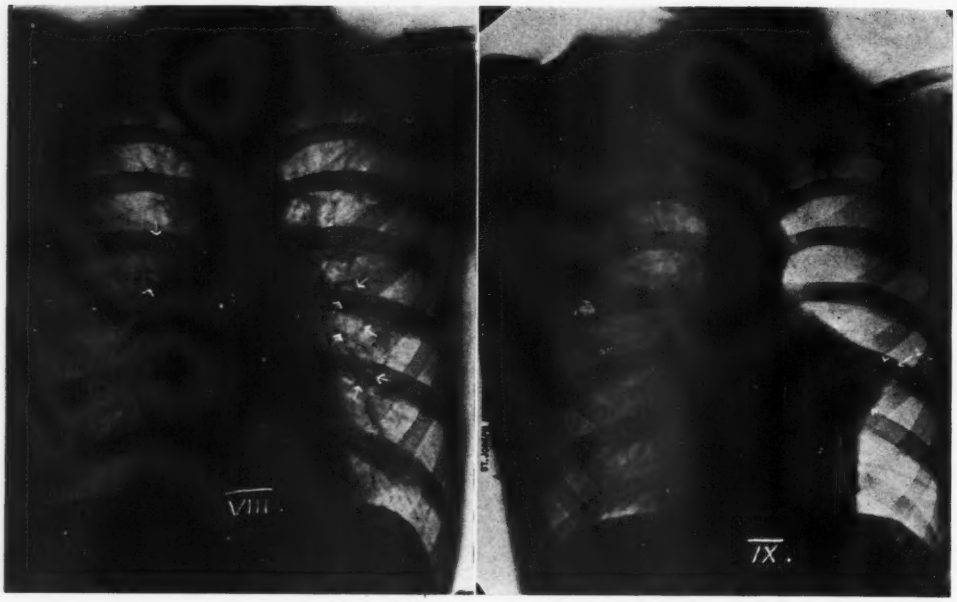

Fig. 8. Complete re-expansion of both lungs (Jan. 8, 1935). The annular shadows (see arrows) are probably vesicles.
Fig. 9. Massive spontaneous collapse of left lung (Aug. 25, 1935). Arrow 2 points to an adhesion.

showed the presence of some yellow, subpleural nodules, probably tuberculous in nature. None of the nodules seen, however, were perforated. The pleural linings were intact. The author does not believe, therefore, that this is sufficient evidence of a tuberculous origin of the left pneumothorax, and, by analogy, of the right. He adds:

"Moreover the successive rupture of a tubercle in the two pleural cavities would constitute a very strange and hardly plausible coincidence, in view of the usual rarity of the process.... It appears more logical to assume that the patient is a carrier of small bilateral tuberculous cicatrices with compensatory emphysema, cicatrices such as are present, undoubtedly, in a large number of clinically healthy individuals."

In his second case, Rossel found no trace of tuberculosis, either recent or old. The right pneumothorax was due, as the autopsy proved, to the rupture of an emphysematous bleb. The origin of the left pneumothorax remained undetermined. The histologic examination of fragments from the apex of the lung revealed a state closely resembling the description that Hübschmann has given of certain cicatrices following minute tuberculous lesions, having given no clinical signs. The cause of the pneumothorax was probably a rupture of subpleural cicatricial emphysematous alveoli.

The problem of treatment is summed up in the question whether to continue these pneumothoraces or to leave them alone. As a rule they absorb very rapidly. Because of the recurrent character of these pneumothoraces, it is necessary, at any price, to obtain pleural adhesion. The continuation of the pneumothorax by repeated refills attains precisely this end. The introduction of air into the pleural sac alters its epithelial linings, which, when the artificial pneumothorax is abandoned, favor the adhesion of the pleural layers. Also, by irritation, this process provokes the new formation of connective tissue, leading to an important thickening of the

serosa. Thus the patients are given the pleural solidity which they seem to lack. Rossel believes that, in general, continuance of the artificial pneumothorax for from six to nine months is sufficient.

According to Sten Grapengiesser (2), spontaneous pneumothorax in apparently healthy individuals manifests itself either by a single attack or by repeated attacks on the same side (in about 20 per cent of the cases), or, very rarely, by alternate attacks on two sides, attacks which are often so close together that they produce a bilateral pneumothorax. Grapengiesser adds to the list of cases reported in the literature one case which he himself observed of alternating spontaneous pneumothorax in which the attacks, first on the right and then on the left, were separated by a period of about a month. Grapengiesser believes that this condition is rare and the prognosis favorable. Consequently autopsies are infrequent and anatomical research is made very difficult. Kjaergaard found in four personal cases, at autopsy, that there was formed in a small bronchus a sort of valve, permitting the passage of air more easily on inspiration than on expiration. Beyond this valve there appeared a "valvular vesicle" which had broken and given rise to the pneumothorax. Kjaergaard thinks that all the cases of simple pneumothorax are due to the rupture of valvular vesicles. Grapengiesser states:

"It is extremely probable that at the appearance of the first pneumothorax, there occurs a factor which favors the production of a pneumothorax on the opposite side. . . . At the time of a sudden unilateral pneumothorax the circulation of blood in the affected lung is found to be obstructed. A larger quantity of blood belonging to the lesser circulation must then suddenly make its way across the capillaries of the unaffected lung. This fact, along with the concomitant dyspnea, leads to a hyperemia which one would suppose would bring about contraction of the small bronchi. Pfanner has shown that a partial bronchial stenosis has a tendency to let pass more easily, like a valve, the air of inspiration than of expiration, which probably means that in the course of inspiration the negative pressure neutralizes to a certain extent the stenosis. A unilateral pneumothorax then would always bring about a hyperemia of the small bronchi of the opposite side, which would favor the production of valvular vesicles on that side. The dyspnea should also lead to a rapid distention of the valvular vesicles in process of formation."

As to the mechanism of development of bilateral spontaneous pneumothorax, Grapengiesser believes that when a pneumothorax is produced on one side and more particularly if it is produced suddenly and is accompanied by intense dyspnea, there is added to the lung of the opposite side an excessive burden which favors in certain cases the production of a valvular vesicle.

Castez and Mazzei (3) call the recurrent spontaneous pneumothorax "benign." They believe, as quoted in the "Journal of the American Medical Association" abstract, that the subpleural blebs form mechanically, at the level of the weaker or slightly altered areas of the lung, at the time of gaseous over-distention at that level. They support this interpretation by the data given at the roentgen and anatomo-pathologic studies of the lung in this condition as well as by results of experiments. They advise roentgenologic search for the presence of fine ring shadows at the contours of the visceral pleura which represent subpleural blebs located at that level. In the roentgenograms of one of the authors' patients the shadows given by the subpleural blebs were evident in all the consecutive roentgenograms. The prognosis and treatment of the condition are the same as those of non-recurrent "benign" spontaneous pneumothorax.

An important contribution to the subject of bilateral spontaneous pneumothorax was made by A. Schmincke (4), pathologist in Heidelberg (see Figs. 1 to 5). Unfortunately, the clinical history given by Schmincke is incomplete insofar as x-ray findings were not mentioned at all. Schmincke autopsied a case of a young woman who, a year before her death, had suffered from dyspnea following physical exertion. The family physician had aspirated clear and sterile fluid from both pleural sacs. After

Fig. 10. Left lung almost re-expanded. A small amount of air is noticeable around the apex.
Fig. 11. Partial spontaneous pneumothorax on right, accidentally found during routine x-ray check-up (Nov. 23, 1935). Patient had no pleural reaction at this time.

admission to a hospital, a bilateral pneumothorax with fluid formation was found. Tubercle bacilli were absent, and there was no fever. After repeated aspirations of fluid and air, the patient's condition improved, but after nine months she died of "increasing dyspnea." The interesting finding in Schmincke's autopsy report was a "compression of both lungs, especially of the left" and, macroscopically, a number of air-filled bullæ in the pleural tissue. With the aid of a magnifying glass, he could detect minute perforations of the cupola of the pleura; he was unable, however, to demonstrate air bubbles escaping through the perforations after injection of air into the bronchial tree. Microscopically, he found normal lungs and normal bronchi, and subpleural cysts connected with the alveoli of the lungs. Figure 1 shows numerous air spaces within the pleural tissue, Figure 2 the beginning of the formation of bullæ, Figures 3 and 4, large bullæ localized just under a thin pleural layer, and Figure 5, a ruptured bulla.

We were fortunate in detecting last year a similar rare case of a young man whose case record reads as follows:

Young healthy male adult, 23 years of age. Previous history negative except for occasional colds of short duration.

Oct. 17, 1934, while sitting in chair, the patient stooped to pick something from the floor. He struck his right side against the chair and felt a slight pain in the middle of his right chest. When he arose and walked, he felt dizzy and short of breath; dyspnea continued and he felt faint. He was taken to the hospital and a chest roentgenogram was made. The film showed a complete pneumothorax on the right side (Fig. 6).

The right chest was strapped for relief of pain. After the right side was strapped, the patient complained of pain in the left chest. He remained in bed ten days.

A roentgenogram made Nov. 10, 1934, showed a bilateral pneumothorax (Fig. 7). One made on Jan. 8, 1935, showed both lungs to be expanded (Fig. 8).

The patient led a normal life, working

daily, from January until Aug. 25, 1935. On that evening he jumped over a stone wall, striking his chest lightly while jumping. The next morning about 11:45 A.M. he felt pain in the lower left chest, and again became dizzy and dyspneic. X-ray examination the next day showed a complete pneumothorax on the left side (Fig. 9). The left chest was strapped for relief of pain and the patient remained in bed for a few days.

A roentgenogram made Sept. 25, 1935, showed the left lung almost re-expanded (Fig. 10). On Nov. 23, 1935, the patient was again checked up roentgenologically and the film showed a partial pneumothorax on the right side (Fig. 11). He had no pleural reaction, however. The clinical, roentgenologic, and laboratory findings were otherwise negative except for diseased tonsils which were removed under local anesthesia, Dec. 19, 1935. He has had no cough or sputum at any time.

On Oct. 28, 1936, after an interval of apparently perfect health, while sitting at the breakfast table he felt again a sudden pain in his right chest. He waited for two days before he came to us again and we found, on fluoroscopy, a new spontaneous pneumothorax on the right side. The left lung was normal. We finally decided to continue the pneumothorax artificially by weekly insufflations of about 350 c.c. of air, given under negative pressure, for about six to nine months, until the visceral pleura should show roentgenographically a thickening which would guarantee a complete obliteration of the right pleural sac after re-expansion. The patient is working steadily and feels comfortable.

In commenting on this case we are inclined to accept Rossel's theory of "same effect, same cause." There was not the slightest evidence of active pulmonary tuberculosis. The parahilar annular shadows seen on the film taken after bilateral re-expansion (see arrows on Fig. 8) are, in our opinion, due to bullæ described by Schmincke (4). The bilateral spontaneous pneumothorax of our patient was of the alternating type. The first rupture occurred on the right side, the second one on the left before the right lung had had the opportunity to re-expand completely (Fig. 7). During the third attack the left side collapsed (see Fig. 9) but an adhesion (see arrow 2 in Fig. 9) between the two left pleural layers, which must have formed after the re-expansion following the second attack, prevented complete compression of the left lung. The pneumothorax on the right following the third attack must have been so small and the opening of the superficial bulla so minute that the patient did not notice any discomfort. It was detected only by accident during the last x-ray check-up.

As to the treatment of our patient, we admit that bed rest and strapping of the chest alone do not guarantee against a further accidental collapse. It is safer to continue the pneumothorax, first on the right, artificially for a while until the x-ray findings show a thickened visceral pleura which, after re-expansion, will remain adherent to the parietal layer. The irritation by artificially insufflated air alone is, in our opinion, sufficient, and we would surely apply artificial pneumothorax on the left also, if another accident should happen.

We do not recommend the use of irritating substances other than filtered air intrapleurally. Sterile mineral oil or saline solution injected into the pleural sac would surely produce a stronger irritation than air, but their use would be too risky. The ideal thing in pneumothorax is to keep the pleural sac dry.

SUMMARY

A case of idiopathic spontaneous bilateral pneumothorax in an otherwise healthy young individual is presented and the recent literature on the subject is discussed.

Pulmonary tuberculosis as a causative agent could be ruled out in our case. It is assumed that the accidental collapse of both lungs is explained by the presence of

subpleural bullæ, as described by Schmincke.

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A RARE DEVELOPMENTAL ABNORMALITY OF THE ATLAS[1]

By W. S. LAWRENCE, M.D., *and* WILLIAM D. ANDERSON, M.D., *Memphis, Tennessee*

THE case forming the basis of this report is that of a white female about 35 years of age whose car, waiting for a light to turn, was bumped into by a street car, causing her head to jerk backward with some degree of violence.

The first x-ray examination in this case was made a few days after the accident, and an interpretation of the films by the attending surgeon as a fracture of the atlas, precipitated legal proceedings.

Our first-sight impression on the examination of the x-ray films in this case, was that they did present a fracture of the atlas. On further and more detailed examination, however, certain points presented themselves which are entirely incompatible with fracture of this bone at the points where fracture, at first sight, appears to be. In this case the posterior portions of the posterior arch of the atlas are separated from the anterior portions of the bone by a space of about one-half inch, in which space no bone at all appears, neither the normal anterior portions of the posterior arch of the atlas nor any fragments of them. The most posterior portion of the atlas though apparently displaced backward is actually in its normal position—not displaced at all. This fact is easily demonstrated by actual measurements on the films of normal necks of the same approximate size. What has become of the bone which normally bridges these gaps of one-half inch between the right and left aspects of the posterior arch and the right and left lateral masses? It is nowhere to be seen in the films of this case.

To answer this question correctly we must recall certain facts concerning the development and ossification of the atlas. Gray's "Anatomy" records the fact that this bone develops by an *inconstant* number of centers, the variation being from two to five. Piersol's "Human Anatomy," 1930 Edition, page 131, records the facts that: "Sometimes the union of the posterior arches does not occur. The anterior nucleus may be absent, and the front arch may show a median suture or be represented by ligament or cartilage. In one instance the anterior arch was wholly wanting, the lateral masses being fastened to the dens by ligament." Another anatomist, Morris, makes record of the fact that ossification of this bone is sometimes incomplete in adult life, and this, of course, means that in such cases the bone cannot be completely demonstrated on the x-ray

Fig. 1. Radiograph of the case reported. Note the total absence of the bone in the arch of the atlas on both sides between the posterior portion and the lateral masses. The relationship between the posterior tubercle of the atlas and the spinous process of the axis is normal.

[1] Presented before the Radiological Society of North America at the Twenty-second Annual Meeting, at Cincinnati, Nov. 30–Dec. 4, 1936.

Fig. 2. Radiograph of a normal neck showing the normally ossified posterior arch and the relationship between the posterior tubercle and the spine of the axis.

film. It also means that any lack of ossification *can* be clearly demonstrated.

The conclusion reached in this case is that it presents a *developmental abnormality in the form of incomplete ossification of those parts of the ring of the atlas which connect its most posterior part with its lateral masses on either side.* To be more accurate, it presents a complete lack of ossification of the parts mentioned. These parts of the atlas, however, are, of course, present in the form of tough semi-rigid hyaline cartilage containing no lime salts.

The claim might be made that the cartilaginous parts of this atlas might be fractured, crushed, or torn from the ossified portions with which they are blended, and that such injury could not be demonstrated by the x-ray film. True enough. Certainly the roentgenogram could offer no *direct* evidence against the existence of such injury. It can and does, however, offer the strongest possible *indirect* evidence, or, as it were, circumstantial evidence against the existence of such fracture. This evidence is to be found in the fact that there is no disturbance of the relationship normally existing between the posterior portion of the atlas and other bones of the neck. One can hardly conceive of a degree of violence just sufficient to crush or tear tough cartilage and still not dislocate in any way bone with which this cartilage was intimately blended. With these facts in mind we are of the opinion that neither the bone nor the cartilage intimately blended with it was injured to any appreciable degree.

Nor do the clinical symptoms in this case suggest fracture. Records of fractured atlas cases show that 53 per cent prove fatal and that in most cases death follows immediately. Other individuals die suddenly as a result of manipulation of the broken bones. A few recover.

In this case both the *objective* and *subjective* symptoms following the injury were so mild that at least one surgeon passed them up as inconsequential. At the time the x-ray examination was made by us, ten days following the injury, the only symptoms elicited were the *subjective* ones of stiffness of the neck and what the patient described as nervousness.

We are reporting this case not only because we believe it to be extremely *rare,* but also because we realize that some day another accident and another incompletely ossified atlas may meet and also be followed by court proceedings. This patient having been assured by her doctor that she had a broken neck, was, in spite of the mildness of her symptoms, suing for $15,000 damages.

We might add that after a copy of our report was sent to the plaintiff's lawyer the case was settled out of court for a comparatively small sum.

We are indebted to Dr. Wittenberg, Professor of Anatomy, Medical Department of the University of Tennessee, for making an exhaustive search of the anatomical literature for information bearing on this case.

DISCUSSION

DR. BYRON H. JACKSON (Scranton, Pa.): I think one cannot add anything to a perfect work, and, of course, I could not discuss Dr. Lawrence's paper by adding anything to what he said.

One thing that this paper has reminded me of and helped me with is that x-ray men should be familiar with embryology. There are so many times when we need to know something about embryology and we pass it up and later on we find, if we had just had embryology and studied the development of some of these things, it would have helped us very much.

Sir Arthur Keith tells us that the cervical vertebræ do not begin to develop until the third month. When we remember that the body and head are connected in the embryo, that there are no arms or legs, and at the third month the neck begins to be formed and the head is pushed away from the body as the heart and the brachial plexus elongate, that probably explains the reason why the cervical vertebræ are sometimes said to be normally anomalous.

Therefore, we ought to familiarize ourselves with the spine and its development so that we may know where these anomalies are likely to occur.

I knew very little about the anatomy of the first cervical vertebra until I went down to the University of Pennsylvania and told them I'd give them three guesses on how much I knew. I brought with me some anomalous first cervical vertebræ. If you men are interested, you can see seven or eight different kinds which Dr. Batson of the Post-graduate School prepared for me.

If we know where these anomalies are likely to occur, we will be looking for them and, furthermore, the ordinary examination of the spine which gives us an anteroposterior and a lateral view of the spine is not sufficient. We have a patient come into our office or into the hospital where we make the regular anteroposterior and lateral views—it is my opinion that a lateral view should always be made with the patient lying on his back.

Dr. Lawrence said in his paper that a fractured first cervical vertebra was a dangerous thing. Dr. Ross Golden says the patient should always be examined by the roentgenologist and not by the technician, because the patient is apt to be killed while the examination is going on.

If we familiarize ourselves with the places where these anomalies are likely to occur, we will find a lot of them in the spine that we have been passing up. For instance, we will find them on the oblique views of the lumbar spine and the dorsal spine, which we rarely make.

I want to also say that when you are examining a spine, do not forget that it is quite important—and Max Hubeny will agree with what I have just said for he wrote a paper about it one time—it is very important to put the patient in the prone position and to make oblique views of the spine.

DR. WALTER S. LAWRENCE: I wish to call your attention, in closing, to one of those specimens that Dr. Jackson so kindly brought—the one on the right hand side just over the white placard there. That simulates the one that I have reported, only in that case there is possibly one-tenth of the posterior ring of the atlas that is not ossified and in the case I reported nearly half of it is not ossified.

X-RAY DIFFRACTION STUDIES OF GLOBULAR PROTEINS

I. EGG ALBUMIN

By GEORGE L. CLARK *and* JOHN H. SHENK, *Urbana, Illinois*
Chemistry Department, University of Illinois

INTRODUCTION

THE early workers in protein chemistry devoted practically all of their time to the problem of isolating and determining the constitution of the structural units present in different proteins. Fischer and others have shown that the amino acids are joined by the peptide linkage into long chains, but the structure of the protein molecule as a whole remained a complete mystery until the last few years when the use of x-rays in the study intact of the molecular structure of complex substances opened up a new line of attack. The study of proteins by means of x-rays is one of the most recent, because one of the most difficult, developments of structure analysis. The fibrous proteins, for the most part, yield patterns rich in information and different fibers give vastly different diffraction patterns, while the non-fibrous or globular proteins, as they are ordinarily available, give patterns which show a monotonous sameness regardless of the source, molecular weight, etc., of the protein. Only recently, by the use of moist samples, have sharp line diffraction patterns been obtained from these globular proteins.

The purposes of this investigation were as follows:

(*a*) to obtain diffraction patterns of crystalline egg albumin and crystalline hemoglobins;
(*b*) to compare patterns of hemoglobins from different species for differences as noted in crystallographic studies;
(*c*) to study denaturation of proteins by chemical reagents;
(*d*) to obtain diffraction patterns of the pigment fraction of hemoglobin.

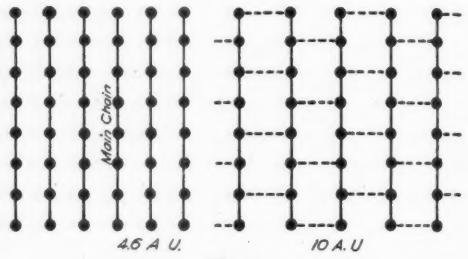

Fig. 1.

These investigations were undertaken because diffraction patterns had been reported for only one hemoglobin, that of rat; no patterns have been reported for hemin or egg albumin, both of which have been obtained in crystalline form many times and denaturation studies have usually been limited to heat and alcohol. The first paper in this series is concerned with egg albumin, the second with hemoglobins, and the third with the effect of formaldehyde on proteins.

THEORETICAL

The use of x-rays for examining the atomic and molecular structure of solids has opened up a new method for investigating complex materials such as the proteins. The work of Brill (1), of Katz and Gerngross (2), Meyer and Mark (3), Astbury (4), and Speakman (5) as well as many others on the x-ray examination of fibrous proteins has given us a much better understanding of the true nature of these substances in their native state. This method is much superior to the chemical method, which destroys the original structure and examines the fragments. The x-ray photographs of silk and the stretched keratins are the only protein fiber photographs about which we may be confident that the main structural features

are known, but practically nothing is known as to the precise details of the individual chains.

A study of the elastic properties of hair in combination with an x-ray examination by Astbury and Street (6) led to the conclu-

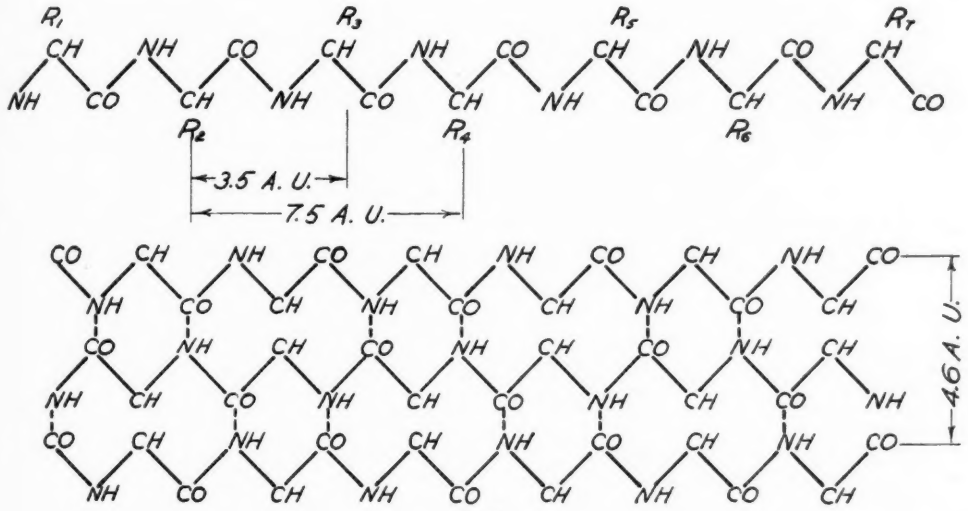

Fig. 2.

X-ray diffraction photographs obtained from proteins, either fibrous or globular, all show two principal spacings, 4.6 Å.U. and 10.0 Å.U. A study of the fiber patterns of silk and stretched keratins leads to the conclusion that they consist of fully extended polypeptide chains which are characterized by two principal side spacings approximately at right-angles to each other, the 4.6 Å.U. spacing arising from the effective thickness of the so-called "backbone" of the chain, and the 10 Å.U. spacing from the lateral extension of the side chains standing out from the amino acid residues. These two spacings appear to represent the two principal linkages between the polypeptide chains and may be represented diagrammatically as in Figure 1. The general formula of a fully extended polypeptide chain and two associated chains, with side chains omitted, is represented in Figure 2.

These chains are supposedly held together in this direction by an attraction between the =CO and =NH groups of neighboring chains ("backbone linkage"). sion that hair consists of folded polypeptide chains and that when stretched the chains unfold, giving a fully extended structure as represented in Figure 2. The globular proteins give evidence of long chains but they are evidently folded and crumpled more than in hair and this would explain why the spacing corresponding to the amino acid residue does not appear in the diffraction photograph. The patterns usually obtained from nonfibrous proteins and those from disoriented fibers are nearly identical, which leads us to the belief that there are two stable and insoluble states of protein structure, the fibrous and the denatured. In the denatured state, there is a general similarity between x-ray powder patterns of proteins. The diffraction pattern in every case consists of two rings, roughly of constant dimensions, but varying somewhat in sharpness. Existing evidence suggests strongly that the inner ring is to be associated with the side chain spacing and the outer with the "backbone" spacing of polypeptide chains. In some denaturation proc-

esses, another ring of spacing (about 3.6 Å.U.) appears, indicating a more highly organized state.

Many attempts have been made during the past years to get x-ray diffraction patterns of the crystallizable proteins, but until recently, no truly crystalline diffraction photographs had been obtained. The patterns always consisted of the two rings mentioned above, even though proteins as different as edestin, egg albumin, and hemoglobin were used. In 1932 Clark and Corrigan (7) reported long spacings from insulin, using long wave length x-rays from a magnesium target. Bernal and Crowfoot (8) found that pepsin crystals rapidly lost their birefringence and crystalline appearance upon exposure to the air. By keeping a crystal moist with its mother liquor during exposure, they were able to obtain single crystal diffraction patterns and to determine the unit cell size. Since then, patterns have been obtained for crystalline urease and pepsin by Fankuchen (9), for rat hemoglobin by Wyckoff and Corey (10), and for Bence-Jones protein by Magnus-Levy, Meyer, and Lotman (11).

DENATURATION OF PROTEINS

Denaturation is a change of a kind not yet understood which the fresh crystallizable protein is capable of undergoing in the presence of water. There is no general agreement among investigators as to whether the alterations of the protein are purely physical, that is, involve only a change in the state of aggregation, or are fundamentally chemical in the sense that there occurs an internal structural rearrangement of the molecule. It is made evident by a decrease in solubility of the protein in water and dilute salt solutions although flocculation is not a necessary consequence of denaturation. The term itself is scarcely capable of adequate definition, but it is generally accepted that denaturation requires the presence of water and that the process is irreversible. The word, "denaturation," is used loosely to designate the change of proteins from a soluble to an insoluble form brought about by a large variety of physical and chemical agents, involving radiation by ultra-violet rays, x-rays and alpha-rays, heat, pressure, shaking, freezing, acids, alkalies, alcohol, acetone, formaldehyde, salts of heavy metals, alkaloidal reagents and enzymes. These products conform to the class of substances known as derived proteins.

Some of these processes have apparently been reversed—such as the reversal of the coagulation of egg albumin by Bancroft and Rutzler (12) and the solution of denatured globin, which was subsequently combined with a hemin derivative to produce a derived hemoglobin by Anson and Mirsky (13). However, merely the fact that a coagulated protein goes into solution or that in solution it may combine with another compound does not give definite proof that the denaturation has been reversed. Chick and Martin (14) have shown that heat coagulation consists of two distinct processes: denaturation, which involves the alteration of the protein, and flocculation. Therefore, the above examples of reversal of denaturation may be merely a reversal of flocculation. Denaturation then seems to be antecedent to and a definite step in the transition of the fresh undenatured (and crystallizable) protein molecule to the amorphous state represented by flocculation. At *p*H values away from the iso-electric point or near the iso-electric point if the salt concentration is of a certain value, denaturation may be effected without coagulation, according to Lepeshkin (15).

It seems that the nature of this phenomenon has been narrowed down to two processes: hydrolysis and dehydration. A few observations will be reviewed which any hypothesis should explain. In the study of heat denaturation of hemoglobin and egg albumin, Clark (16) comes to the conclusion that there is a chemical reaction with water because of the high temperature coefficient of heat denaturation, but that it takes place at any tempera-

ture. Harris (17) observed that in denaturation there is a production of sulphydryl groups. Treating with acids and alkalies increases the acid-and-base-binding powers of the protein, according to Wu and Yen (18). A determination of individual amino acids by Kiesel and Kuzmin (19) in edestin prepared by extraction with NaCl before and after treatment, whereby a soluble and an insoluble product were obtained, shows differences in the tyrosine, histidine, arginine, and tryptophane content. The differences in the tyrosine, histidine, arginine, and tryptophane are attributed partly to adsorbed proteolytic enzymes and partly to intermolecular ring closures. Since there is no change in p_H, Lewis (20) claims that there is no hydrolysis of a peptide linkage unless there is a simultaneous and equivalent change elsewhere in the molecule. The fact that denatured protein is more easily attacked by proteolytic enzymes in the act of digestion points to a

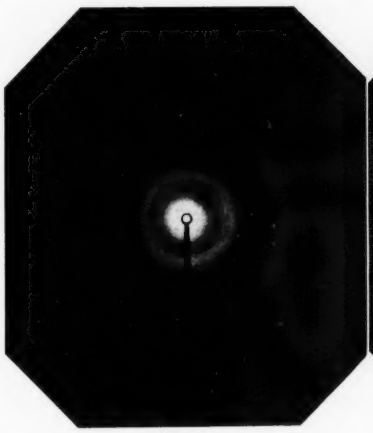

Fig. 3.

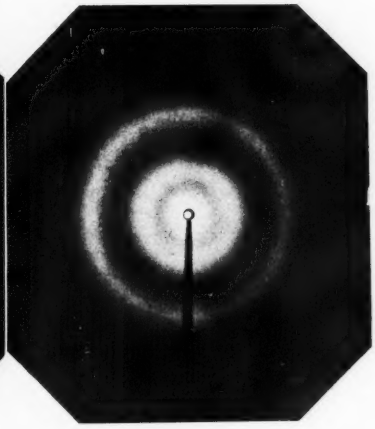

Fig. 4.

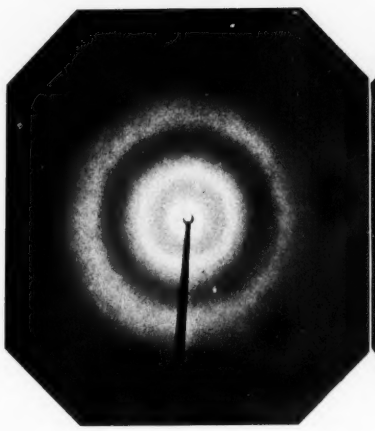

Fig. 5.

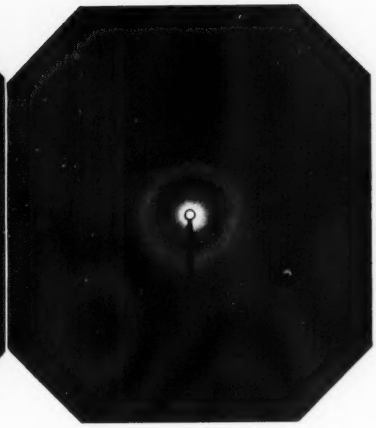

Fig. 6.

Fig. 3. Egg albumin, air-dried.
Fig. 4. Egg albumin, salt-precipitated.
Fig. 5. Egg albumin, picric acid-precipitated.
Fig. 6. Egg albumin, trichloroacetic acid-precipitated.

more penetrable and less tightly bound structure—indicating at least a partial hydrolysis.

It has often been assumed that heat denaturation is due to dehydration and, therefore, the viscosity of the solution should have a lower value, but Loughlin and Lewis (21) showed that solutions of completely denatured proteins gave higher viscosities than natural ones. This apparent contradiction was overcome by Kruyt and de Yong (22), who postulated that the increase in viscosity was due to an increase in the particle size. Keyman (23) found that heat denaturation was accompanied by a volume increase, which would be expected if dehydration occurred because the water liberated possessed a larger specific volume than when oriented or compressed as a result of attraction between colloidal particles. Adding alcohol to albumin solutions first produced denaturation and then an insoluble precipitate formed, according to Lepeshkin (24). The process seemed to be reversible and very similar to the coagulation produced by salts. The addition of alcohol results in a distribution of water between the alcohol and the albumin, and hence dehydration of the albumin.

One of the most certain indications of structural alteration in a chemical compound is the change in molecular refractivity. The refractivity of egg albumin is found to increase with heat denaturation and Barker (25) interpreted this as being due to a structural rearrangement within the molecule. Several authors have discussed the possibility that denaturation results from a change of intermolecular polarization due to a change of position of some groups of the protein. Astbury and Lomax (26) conclude from x-ray investigation that the polypeptide chains become more regularly arranged in the molecule during denaturation. It has also been suggested that the laying down of proteins as fibers in the animal body may be considered as a denaturation process.

EGG ALBUMIN

Historical.—Egg albumin, because it is one of the most common proteins of our diet and because of the allergic reaction of many individuals to egg protein, has probably received more attention than any other protein. The earliest scientific journals contain records of research on this substance. It is one of the simple proteins yielding only alpha-amino acids upon hydrolysis. Methods for the preparation of crystalline egg albumin have long been known. One of the earliest methods is that of Hopkins and Pinkus (27), who crystallized egg albumin by acidifying with acetic acid, the solution prepared from fresh eggs by diluting with saturated ammonium sulfate solution and filtering. A slightly different method using sulfuric acid instead of acetic acid is that of Sorensen and Hoyrup (28). Early determinations gave the molecular weight of egg albumin as about 5,000, but recently McBain (29) and his co-workers determined the molecular weight to be 34,000, using diffusion through a porous membrane of constant properties as the basis of their determination. This value agrees fairly well with the ultracentrifugal method of Svedberg (30), who reported 34,500. There is no protein whose physical-chemical properties have been more thoroughly investigated than those of crystalline egg albumin and among the many investigations, that of denaturation has played a very important part.

Denaturation Studies.—The solution for these studies was prepared from crystalline egg albumin obtained as will be described later. The crystals were filtered off, the excess liquid removed by suction, and then dissolved in distilled water. A measured amount of solution was evaporated to dryness, the weight of residue determined, and the remaining solution diluted to give a 1 per cent solution.

The samples were prepared by adding the precipitating reagent drop by drop to 100 ml. of the egg albumin solution until

precipitation appeared complete. The precipitating solutions used were 0.1 *M* solutions of inorganic salts, 95 per cent alcohol, acetone, formalin, 10 per cent trichloroacetic acid, saturated picric acid and tungstic acid solution made by mixing equal volumes of $^2/_3$ *N* sulfuric acid and 10 per cent sodium tungstate. With the inorganic salts, the amounts required varied considerably, from 10 drops of ferric chloride and copper nitrate solution to 4 ml. of the silver nitrate solution. In most cases some protein was left in solution. Very complete precipitation was accomplished with mercury, silver, alcohol, trichloroacetic acid, picric acid and tungstic acid solutions. Precipitates were formed with salts of iron, copper, mercury, and silver. At first, Mallinckrodt's egg albumin was used, but it does not dissolve in distilled water to give a perfectly clear solution, and a precipitate was formed with salts of nickel, cobalt, manganese, chromium, and aluminum. The precipi-

Fig. 7.

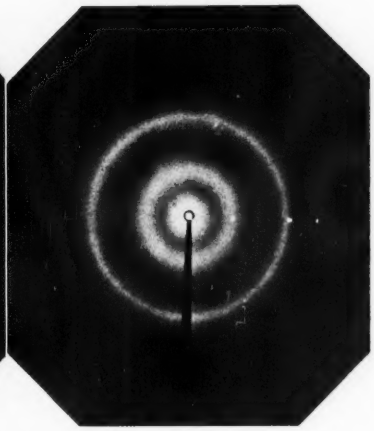

Fig. 8

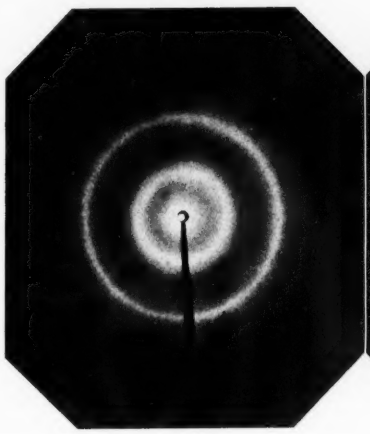

Fig. 9.

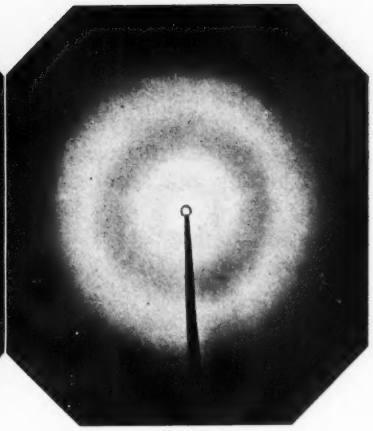

Fig. 10.

Fig. 7. Boiled egg white, air-dried.
Fig. 8. Heat-denatured egg albumin.
Fig. 9. Heat-denatured at $p_H = 3$.
Fig. 10. Egg albumin, alcohol-precipitated.

tation was probably caused by a neutralization of the charge on the colloidal protein particles by the ions of the metals just named, because they gave no precipitate with the solutions of crystalline egg albumin. The precipitated protein was allowed to stand over night to allow it to settle, after which the supernatant liquid was poured off and the precipitate removed by centrifuging. To remove the remaining liquid, the moist precipitate was placed on a porous plate until it was dry enough to handle (5–15 min.) and then molded into small flat pellets and allowed to finish drying in the air. These were very convenient to handle and could be held in place easily during exposure. Drying over phosphorous pentoxide seemed to have no advantage over air-drying.

All diffraction photographs were obtained by the transmission of a beam of x-rays 0.025 inch in diameter through the sample and registering the pattern on a flat film 5 cm. from the sample. The x-rays were generated by a copper targeted Philips Metalix x-ray diffraction tube operated at 30 kilovolts and a current of 25 milliamperes. The beam was passed through nickel foil to render it more nearly homogeneous.

The protein precipitated by the inorganic salts always contained some of the salt because when colored ions, such as those of copper and iron, were used, the dried product possessed the corresponding color. One cannot say in what manner the precipitation is brought about since it is impossible to determine by analysis whether the metallic ion is actually in combination with the protein, whether it is just adsorbed, or whether the salt changed the *p*H to the iso-electric point. The x-ray diffraction photographs do not show new lines, which would indicate compound formation, but that is not conclusive evidence that there is no compound formed, since the combined atoms may be relatively far apart or randomly spaced, so that no strong interference will appear. It is also quite possible that molecular compounds may be formed. In Table I are *p*H determinations of some of the solutions after precipitation.

TABLE I

Reagent Added	*p*H
Cupric ions	4.8
Ferric ions	4.9
Mercuric ions	5.1
Tungstic acid	4.9
Picric acid	4.2
Trichloroacetic acid	2.6

Since the *p*H of the iso-electric point of egg albumin is 4.6, it appears from the above table that in some cases the precipitation is due to adjustment of the *p*H, but this is not always true, because silver ions will precipitate egg albumin from a solution with a *p*H = 1. The silver precipitation must be carried out in very diffuse light or the precipitate becomes black. In very diffuse light, the precipitate, when dry, is a very light tan color. There, probably, is compound formation between proteins and silver ions, trichloroacetic acid, tungstic acid and picric acid. The denaturation of egg albumin by dilute salt solution can hardly be attributed to hydrolysis or dehydration because the treatment was very mild and the solution was very dilute with respect to the precipitating agent.

The x-ray diffraction photographs of salt-precipitated egg albumin resembles that of air-dried egg albumin very closely (compare Figures 3 and 4). Figure 4 is representative of the pattern obtained from egg albumin precipitated by metals. In both cases there are two rings, neither of which is very sharp, the outer ring of spacing (about 4.6 Å.U.) representing the "backbone" spacing, and the inner ring (about 10 Å.U.) representing the side chain spacing. The outer rings in both cases are broad and diffuse, showing that there has been very little change in the protein when denatured by precipitating in very dilute solutions of metallic salts.

Precipitation with picric acid likewise causes little change in the x-ray pattern

as shown in Figure 5. The outer ring is broad in this case also, with very little change in the inner ring. When trichloroacetic acid is used, the interferences are decidedly sharper, especially the outer ring, as was also noted by Astbury and Lomax (26) in the denaturation of proteins by heating. The reaction is probably between the acids and the basic groups of the protein molecule, or there may be a molecular compound formed. It would be expected in the latter case that the outer ring would remain quite broad, but trichloroacetic acid tends to orient the molecules and, therefore, gives a much sharper interference.

In heat denaturation, there is supposed to be a partial hydrolysis. This would produce more polar groups, which ordinarily would make the molecule more soluble. Since the substance becomes more insoluble, it would seem logical to assume that there is probably a reaction between groups already free, to form a higher molecular weight polymer which is less soluble. Heat produces an increased regularity in the structure of the denatured protein in egg white, as shown in Figure 7. The two rings ordinarily found are fairly sharp, especially the outer one, and there is a very faint ring appearing farther out at about 3.6 Å.U., which may be due to the amino acid residue length. Heat precipitation from a solution of crystalline egg albumin gave a similar pattern (Fig. 8). When denaturation by heat is carried out at $p_H = 3$, no precipitation takes place, but it may be coagulated by adding 0.1 normal potassium hydroxide slowly. The precipitate treated as above gives the pattern shown in Figure 9, in which the 3.6 Å.U. spacing is stronger than in the patterns obtained by denaturation at p_H near the neutral point.

If the protein is denatured by the addition of alcohol, which is probably due to a distribution of water between the alcohol and the albumin or a dehydration process, there is a more regular aggregation than in untreated egg albumin (see Fig. 10). The same was found to be true in the precipitation of egg albumin with acetone and formalin, the outer ring being fairly sharp. Although, the outer ring can be greatly sharpened, the width of the inner ring changed very little regardless of the denaturation process. This is to be expected since the chains are held together by chemical bonds laterally and only by coordinate linkage between the grids. Therefore, an entering group or molecule would tend to push the chains out of shape in this direction, producing a broad outer ring.

Fig. 11. Egg albumin, tungstic acid-precipitated.

The product obtained by precipitating with tungstic acid is highly absorbent to x-rays and a very long exposure is required to obtain a visible pattern. The two protein rings appear faintly in Figure 11 with intense fogging near the central spot, which is probably due to large colloidal aggregates.

Crystalline Egg Albumin.—The crystalline egg albumin used in this investigation was prepared according to the method of Sorensen and Hoyrup (28), who used the essential features of the method of Hopkins and Pinkus (27). The whites of 24 eggs (about 700 ml.) were stirred briskly together with an equal bulk of a saturated

solution of ammonium sulfate and the precipitate filtered off. To this clear filtrate, saturated ammonium sulfate was added until incipient turbidity was reached (about 35 ml.) and again filtered. N/5 sulfuric acid was added to 100 ml. of this solution until a voluminous, amorphous precipitate was formed, which, at first, dissolved by stirring, but later became more difficult to dissolve and finally remained turbid. The quantity of acid to be added to the whole filtrate was calculated and added with mechanical stirring. This gives a favorable *p*H for crystallization. Several drops of toluene were added to prevent putrefaction and the solution was set aside for two days for crystallization, although a heavy precipitate had formed in six hours. The crystals may be filtered by suction but are more difficult to dissolve than if filtered otherwise. The composition of the wash solution is determined by preparing a series of test tubes, each containing 10 ml. of the filtrate. The most concentrated solution which will not give a precipitate is used as the wash solution. This preparation was quite soluble in water, giving a clear, colorless solution and may be recrystallized by dissolving in water, adding saturated ammonium sulfate solution until the precipitate which is formed will just dissolve by stirring, and then proceeding as above. The crystals are quite stable at room temperature if they are kept moist with their mother liquor.

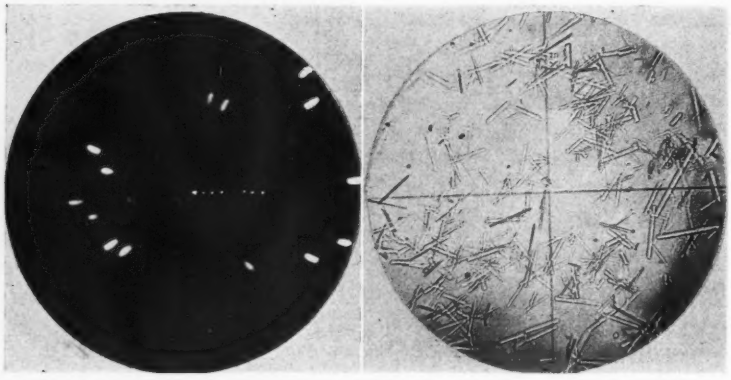

Fig. 12. Fig. 13.

Fig. 12. Crystalline egg albumin.
Fig. 13. Photomicrograph of crystalline egg albumin.

Since the crystalline structure is destroyed upon drying, it is necessary to keep the sample moist during exposure. The mother liquor was removed until the crystal mass was of the consistency of thick paste, after which this material was forced into a hole in a brass strip and covered with thin sheets of mica. Mica was used because it gave only spots which did not interfere with the rings given by crystalline egg albumin. To reduce background fogging so that the rings might be detected more easily, the film and sample were placed in a vacuum camera. The x-ray beam was passed through a pinhole 0.01 inch in diameter and the film-to-specimen distance was 10 centimeters.

Figure 12 shows that the egg albumin was definitely crystalline because several sharp rings appear. The interplanar spacings together with their relative intensities are given in Table II.

Some of the rings did not reproduce well, so the positions of all rings are indicated by the ink spots in a straight line. The large spots are due to the mica windows used to keep the sample moist during exposure. Figure 13 is a photomicrograph of egg albumin crystals and shows their definitely crystalline shape. The

TABLE II

Ring No.	Spacing in Å.U.	Intensity	
1	57.0		
2	39.0	vw	
3	28.1		Second order of No. 1
4	21.3		
5	11.9		Beta of No. 6
6	11.8	w	
7	10.2		Second order of No. 4

crystals are very brittle, so that care had to be exercised in placing a cover glass over them to prevent loss of water while taking a photomicrograph. Upon drying in air, these crystals lose their shape and the diffraction pattern consists of only two rings, neither of which is strong enough to be seen in the crystal pattern.

SUMMARY

1. Air-dried precipitates formed by the addition of dilute salt solutions and picric acid to an egg albumin solution give x-ray diffractions similar to that of air-dried egg albumin.

2. Egg albumin precipitated by trichloroacetic acid, alcohol, and heat give essentially the same patterns but the two rings are much sharper, especially the outer one.

3. When egg albumin is denatured by heat at $p_H = 3$ and then precipitated, the rings are quite sharp and another ring appears faintly in the diffraction pattern.

4. Crystalline egg albumin was prepared. A photomicrograph and a diffraction pattern are shown, both of which prove its crystallinity.

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IDIOSYNCRASY, HYPERSENSITIVENESS, AND DOSE INTOLERANCE[1]

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THIS paper is not intended to be, nor is it in any sense, a discussion of these conditions *per se;* but it is presented at this time as an argument that these conditions do exist as true clinical entities and to emphasize the importance of remembering their existence, so as the better to be prepared when their occurrence results in clinical and legal complications.

The question of idiosyncrasy, hypersensitiveness, or normal dose intolerance is frequently an important element in the defense of malpractice litigation, brought because of alleged injuries produced by the roentgen rays. This has been particularly true of some of the more recent suits brought to the writer's notice.

For medico-legal purposes, it is considered best that we discuss and handle idiosyncrasy, hypersensitiveness, and variations of dose tolerance or tissue tolerance as one subject. The writer, therefore, combines these under the same title heading, and again calls the attention of radiologists to the necessity of recognizing these conditions and keeping them in mind, in their daily handling of patients as well as in the defense of malpractice lawsuits. I say *again*, because I have several times called your attention to this same subject—before the Section on Radiology of the American Medical Association and in our Journal, RADIOLOGY.

It is safe to say that there are no dosage formulæ which can be expressed or expounded so as to apply absolutely to all patients or even to any considerable number or group of individuals, without provision for, or consideration of, individual peculiarities of toleration of the normal amount of the remedial agent intended or expected to be used. Dosage of drugs, medicaments, or remedies cannot be set at one categorical figure because no two individuals react identically, and we can have no *a priori* knowledge of what the exact effect of any stimulant, depressant, or other medicament may be. True, we know what the average effect should be, or what the effect of certain dosage on an average individual might be expected to be; but it is not the average effect nor the average individual that produces the unusual or the unexpected result, and both directly and indirectly cause our trouble.

Those of us who have been in general practice have seen patients who develop a violent and severe coryza after taking small doses of K.I. I had one such, who developed a "running nose" after taking two grains three times a day, but who could and did take 30 grains twice a day for a considerable time without any ill effect. Likewise, we have seen itching, erythema, and delirium produced by moderate dosage of belladonna, and deafness and blindness following the administration of three grains of quinine sulphate.

Now, with all of these various and numerous manifestations of idiosyncrasy, hypersensitiveness and/or variations in dosage toleration, is it at all remarkable or surprising that some persons show unusual reactions to the roentgen rays? Would it not be far more surprising if we did not ever have patients show unusual reactions?

Reasoning from the known and acknowledged effect on patients of nearly everything used in medicine, from aatharilal to zymotoid, we have a right to expect and to believe that there might be some unusual or unexpected reactions or effects from the roentgen rays. And just as it is with all other things in medicine in this regard, we have no means of determining what, if any, variation or departure from the normal and usual effect or reaction may be, or in whom to expect it.

The earliest workers with the roentgen rays discovered this, and wrote about it.

[1] Presented before the Radiological Society of North America, at the Twenty-first Annual Meeting, in Detroit, Dec. 2–6, 1935.

Freund[2] said: "It is of greatest importance to bear in mind that the tissues of different individuals do not possess the same sensitiveness to x-rays. Many authors deny this, though it would appear that even they have met with differences in the mode of reaction of different persons."

Pusey[3] said: "According to general opinion there is a difference in the ways in which tissues of different individuals react to the influence of x-rays. The only radical exception to this opinion that I know of is that of Kienböck[4] who takes the position that we are not justified in assuming an idiosyncrasy to x-rays." He goes on further and states: "A fact of the greatest importance, from a therapeutic standpoint, is the knowledge that individuals in good health react in precisely a similar manner to x-ray radiance." In my judgment there is no evidence to justify such a statement. The very fact that x-ray burns are comparatively so few, demonstrates in the largest and most convincing way the inaccuracy of such a position. It is literally true that at the present time (Pusey wrote this in 1904), millions of x-ray exposures have been made, and most cases of burn of a severe character come to light; yet Codman, in considering the subject of x-ray injuries, is able to find recorded in all the literature only 170 burns. Gilchrist[5] in reviewing the literature in February, 1897, was able to collect only 23 cases, and Stone Scott,[6] in reviewing the subject in May, 1897, was able to find only 69 cases. With the thousands of x-ray exposures that have been made, is it to be supposed that only 170 cases have been exposed beyond the point of safety? Or even assuming that only one in ten cases of severe burn has come to light, is it to be supposed that only 1,700 cases of over-exposure have taken place? Probably in one month, three or four months after Röntgen's discovery was announced, over 1,700 cases were exposed in a way that we now know to be dangerous. Many cases of burn have unquestionably been caused by dangerous exposures; on the other hand, it is certainly true that thousands of what are dangerous exposures for some individuals have been made without injury. The fact that in innumerable cases individuals have escaped x-ray effects, while in a few cases under similar conditions injuries have occurred, can be accounted for only by the existence in a few individuals of certain factors rendering them more susceptible to x-ray influence. Such a statement as Kienböck's, founded as it is upon personal opinion regardless of recorded facts, needs to be challenged. It is most mischievous in the influence which it may have upon technic; there are enough x-ray injuries due to faulty technic without throwing out so well-established a fact as personal idiosyncrasy to account for some of them.

Kienböck states:

"In the therapeutic use of x-rays when one has occasion to give exposures daily or very frequently over a long period of time, the opportunity to observe personal idiosyncrasy is excellent. It has been my experience to see variations in the susceptibility to the tissues of different individuals to the influence of the x-rays. One patient will develop x-ray irritation after repeated exposures during two weeks. Another patient, under conditions of technic which are as nearly identical as care can make them, will not develop a similar irritation until two months have passed. He may then develop a reaction which is no greater, which runs no longer course, and which differs in no essential particular in degree or character from the reaction of the other individual, which was set up at the end of two weeks of similar exposure.

"It may be said, I believe, that a moderate variation in the susceptibility of individuals is constantly found, but that this difference rarely amounts to more than four times as great susceptibility in one individual as in another. In extremely rare instances this susceptibility amounts to a marked idiosyncrasy, but this idiosyncrasy is rare. On the basis of Codman's statistics, for example, it

[2] Elements of General Radiotherapy. Leopold Freund (Vienna); translated by G. H. Lancashire. Published by Rebman, London, 1904, p. 247.

[3] The Roentgen Rays in Therapeutics and Diagnosis. William Allen Pusey and Eugene Caldwell. Published by W. B. Saunders Co., Philadelphia, 1904, 2nd ed., pp. 244–246.

[4] Wien. klin. Wchnschr., 1900, **13,** 1153, and Wien. klin. Presse, 1901.

[5] Johns Hopkins Hosp. Bull., 1897, **8,** 17.

[6] Trans. Ohio St. Med. Soc., 1897, **52,** 139.

occurs less frequently than once in ten thousand individuals. This fact of idiosyncrasy must be taken into consideration in the application of the agent. It is the one fact whose avoidance requires the most care in the application of x-rays to therapeutic purposes."

Personal communications and statements of this well-known and highly credited dermatologist indicate that he has not receded from his position nor changed his opinion regarding this subject, in the 32 or more years since the foregoing was written.

A. E. Walter, in a little-known and seldom-seen useful little handbook,[7] published in 1906, said: "Some authors think that they have observed marked susceptibility on the part of certain patients, and no doubt a certain amount of idiosyncrasy must exist."

I will quote verbatim from page 96 of "The Use of the Roentgen Ray by the Medical Department of the United States Army in the War with Spain," by Captain and Assistant Surgeon W. C. Borden, published at the Government Printing Office in 1900:

"Personal idiosyncrasy and low vitality has always to be taken into account. The first, fortunately, is very rare, but as it cannot be determined beforehand, the same should always be considered. A person in ill health or debilitated is undoubtedly more likely to be burned by the roentgen rays than is one who is strong and vigorous. The well-known fact that weakened tissues easily yield to disturbing forces, holds with the action of the roentgen rays as with other factors, the action of which, if too long continued, devitalizes the cells."

Is it not remarkable that these last early observations should be made by one who was handling and studying only the most rugged and vigorous young men—soldiers in the army? While we might suppose that idiosyncrasies would be less frequent among these patients than among those in our daily practice in civil life, perhaps that argument is not so tenable as we at first thought it might be.

That much from a very few of the early observers; the more recent users and writers make it more nearly certain that we have to contend with idiosyncrasy and unstable or irregular tolerance of normal dosage.

MacKee,[8] in summing up a very comprehensive thirteen-page discussion of idiosyncrasy, said:

"1. Variations in cutaneous susceptibility to x-rays and radium and due to known causes are of daily occurrence. These variations may be well marked. They cannot be regarded as true idiosyncrasy.

"2. Slight variations in susceptibility of unknown and undiscoverable cause are not common, and may be considered as mild examples of true idiosyncrasy.

"3. The existence of true idiosyncrasy of severe type is admitted, but it is rarely encountered.

"4. Individual peculiarities, relative to pigmentation, defluvium, telangiectasis, atrophy, etc., are common and can probably be regarded as examples of idiosyncrasy."

Hirsch[9] said:

"In general, it may be stated that the skin reaction is, within narrow limits, the same in different individuals with the same radiation dosage. However, unusually severe reactions in some individuals have been reported. . . .

"That there exists a hypersensitivity and hyposensitivity to the radiation as a deviation from the standard of sensitivity of the particular tissue is beyond doubt. This is an abnormal reaction and cannot be foretold."

While discussing a paper by Dr. MacKee and Dr. Morse[10] before the Section on Radiology of the American Medical Association in 1927, Dr. George E. Pfahler—recognized as one of our safest and best-informed radiotherapists—said:

"If one obtains the standard of the dose by treating a small area of the skin, a very much larger dose will be obtained over a larger area

[7] X-rays in General Practice. A. E. Walter, p. 58, Lane, London. Published by John Lane Co., New York, 1906.

[8] X-rays and Radium in the Treatment of Diseases of the Skin. George M. MacKee. Published by Lea & Febiger, Philadelphia, 1907, 2nd ed., pp. 368-381.

[9] Principles and Practice of Roentgen Therapy. I. Seth Hirsch, p. 308, American X-ray Publishing House, New York, 1925.

[10] The Present Status of Cutaneous Roentgen Ray Therapy: Transactions of the Section on Radiology, A. M. A., 78th Annual Session, p. 82, Washington, 1927.

and tremendous damage may be done. Keep that in mind. There is considerable variation in the skin of individuals. Therefore, if one uses a test upon oneself or one's friend and takes that as a standard, it may be of little value, and it will have much less value if taken on a dog or animal. It is questionable whether one can transfer that dosage directly to some stranger. There is about a 25 per cent variation of safety in treating cases at any time, and that 25 per cent of leeway keeps us out of lots of trouble. It helps, therefore, to use a dose that is not absolutely exact. There is a tremendous variation in the amount of radiation that different individuals can stand, and that is not surprising. If one can find 100 per cent variation in a litter of mice of the same age and that comes through the same stock, there should be a tremendous variation in a group of individuals such as are here present, who have all kinds of variations in ages and conditions. When anything happens to a patient, it is not always due to faulty technic."[11]

The writer followed Dr. Pfahler in the discussion of the same paper, and having been considering from the medico-legal aspect what the essayist had stated, I said: "It is difficult for anyone not familiar with the exact conditions found, to draw the line separating idiosyncrasy and dose intolerance. Quite a number of malpractice suits have been won on the basis of the existence of idiosyncrasy, so that when we begin to discuss the dividing line between idiosyncrasy and intolerance to regular dosage, we must be careful to express ourselves so as not to be misunderstood or misquoted. The celebrated Texas case of Hamilton *vs.* Harris went to the State Supreme Court twice on this very question, and other State supreme courts have had this subject under consideration and have made idiosyncrasy a most weighty matter in their decisions. Lawyers have learned that idiosyncrasy plays an important part in determining whether an overdose of radiation or any other therapeutic agent has been administered, and I am sure that a large majority of the trained radiologists in this country and throughout the world firmly believe that this condition does exist, and that there is no way by which we can foretell whether it does or does not exist in any given individual."

Dr. MacKee, in closing the discussion, said in part:

"Idiosyncrasy is inherent and constant and parallels longevity. Variations in tolerance may be due to many causes, and they are likely to fluctuate. There is no irrefutable proof that true idiosyncrasy to the roentgen rays exists, although there is some evidence in favor of mild degrees of idiosyncrasy. Rather marked examples of tolerance variations are common."

The writer has seen idiosyncrasy and hypersensitiveness to the average dosage of the roentgen rays, as well as to numerous and various other remedial agents during the last 39 years, just as have all the other users of medicine in every branch and specialty. We have all seen these phenomena, and we must not forget about them.

Beside the foregoing, idiosyncrasy, variable tissue tolerance, and hypersensitiveness to roentgen radiation has been mentioned, described, discussed, and commented upon by Codman, E. E. King, Williams, Gilchrist, Scott, Scherer, Rollins, Baetger, Manges, Johnston, Witherbee, Hickey, Hazen, Pancoast, Brown, Boggs, Jaches, Remer, Skinner, Barthelmy, Wolbach, Donaldson, and numerous others in this country, and by Kienböck, Scholz, Arcelin, Lancashire, Jutassy, Benedikt, Holm, Albers-Schönberg, Schiff, Ehrmann, Holzknecht, Bergmann, Oudin, Mühlman, Peterson, Sippel, Hellmann, Regaud, Thedring, Perthes, Wetterer, Hall-Edwards, Lacassagne, Wintz, Colwell, Seitz, Holfelder, Apostoli, Knox, and many others in Europe.

Age toleration of radiation is recognized by all who have had much experience in roentgen therapy. Some sixteen years ago, Holfelder presented a table showing the percentage of skin tolerance of individuals from two months to over eighty years of age. This table is worthy of study and consideration and is here given for that purpose.

Infants 2 to 3 months	20–25%
Infants 4 to 6 months	25–30%
Infants 7 to 12 months	30–35%

[11] Can you not close your eyes and see the earnest white-haired Pfahler saying that? I can.

Children in second year	35–45%
Children in third year	50–60%
Children fourth to seventh year	60–70%
Children 7 to 10 years	70–80%
Children 10 to 16 years	80–100%
Persons 17 to 60 years	100%
Persons 60 to 70 years	110%
Persons 70 to 80 years	120%
Persons over 80 years	130%

With all this evidence, from the numerous sources, it behooves us to be just a little more careful and particular in the handling of our patients, in both diagnostic and therapeutic procedures.

This additional care will help in more than one way to prevent trouble, because, when we become habituated to exercising greater care in this, the exercise of greater care will become routine with us, and we will be the better physicians for it.

The principal purpose of this presentation is to call it to the attention of some radiologists who might become a little lax in their dosage, for the moment forgetting about idiosyncrasy and the variations in dose toleration, and give just enough overdosage to cause trouble.

Malpractice suits are much easier to defeat or to win it they are not started, and if we keep ever before us the realization that some individuals do not tolerate as much as others, not only of sodium salicylate, belladonna, or epsom salts, but also of the roentgen rays. If we do this there will be fewer medical malpractice suits filed and less grief for those who help to fight them.

Readers of my papers and discussions, as well as the unfortunates who are present when I talk, know that I have from time to time mentioned this sort of thing before. I have repeatedly said that it is better to be safe than sorry, and in my recent series of papers in RADIOLOGY, on "Some Lawsuits I have Met," I tried to maintain the same cautionary warning. I expect to continue my talking and writing along these same lines as long as my tongue will wag and my hand hold a pen.

Fortunately, radiologists do not seem to present any evidence of idiosyncrasy, but on the contrary, tolerate enormous amounts of punishment in the way of oft-repeated advice, abuse, and reiteration. If that were not true, I might not have the temerity to present this and you would neither listen to it nor read it after it is printed.

SURGICAL ANATOMY OF THE ABDOMEN[1]

A ROENTGENOLOGIC STUDY

By SAMUEL BROWN, M.D., *and* ARCHIE FINE, M.D., *Cincinnati, Ohio*

THE scope of this paper is concerned with certain principles which have been found helpful in the roentgenologic study of the surgical anatomy of the abdomen. These are as follows:

(1) The study of the position, shape, and mobility of the diaphragm.
(2) The study of the abdomen by plain views.
(3) The study of the position, shape, size, and the relationship of the stomach and bowels to the neighboring viscera.
(4) The study of the mobility of the gastro-intestinal tract.
(5) The study of the contour of the stomach and bowels in various positions.

Diaphragm.—The diaphragm, situated as it is between the thoracic and abdominal cavities, may be affected by abnormal changes of the organs therein, which may alter its position, shape, and mobility. To enable one to recognize departures from the normal, its roentgen anatomy must be understood. This having been described in a previous publication (1), attention will be called only to certain anatomical characteristics. Its shape resembles a dome, and is higher anteriorly and medially than posteriorly and laterally. By its central tendon it is attached to the pericardium, and by its lateral projection, to the thoracic cage. In the antero-posterior view of the chest (Fig. 1-*A*),

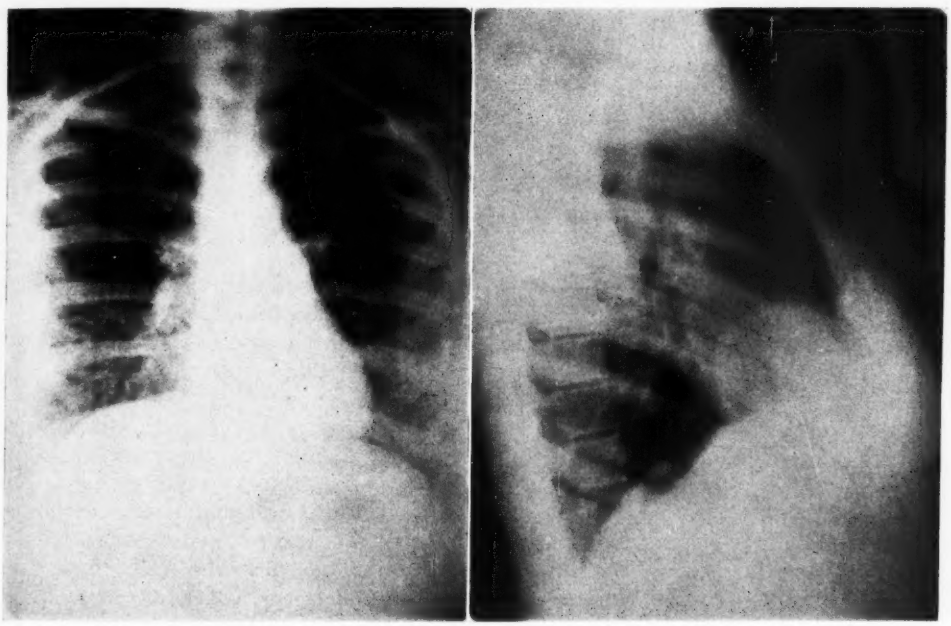

Fig. 1-*A*. Fig. 1-*B*.

Fig. 1-*A*. Only the crest of the diaphragm is seen, the rest of its surface being obscured (anterior view).
Fig. 1-*B*. The entire surface of both leaves of the diaphragm is brought into view. It will be noted that the posterior attachment is on a much lower level than the anterior (lateral view).

[1] Presented before the Radiological Society of North America at the Twenty-second Annual Meeting, at Cincinnati, Ohio, Nov. 30–Dec. 4, 1936.

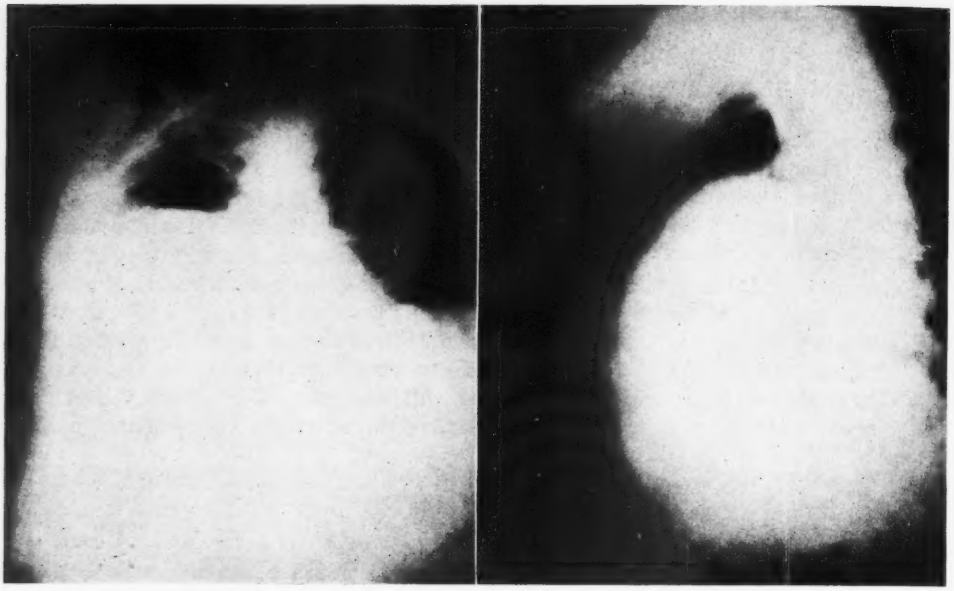

Fig. 2-*A*. Fig. 2-*B*.

Fig. 2-*A*. The diaphragm is elevated on the right side. The lung appears to be free from any abnormal changes (posterior view).

Fig. 2-*B*. The right diaphragm is elevated through its entire expansion, being on the same level with the crest and thus resembling a "plateau" frequently met with in cases of subphrenic abscess (lateral view).

only the crest of the diaphragm is seen, the rest of its surface being obscured; in the lateral view (Fig. 1-*B*), the entire extent of both leaves of the diaphragm is brought into view.

There are numerous processes which may increase the intra-abdominal pressure, thus altering the shape, mobility, and position of the diaphragm. Among these may be included free fluid or gas in the peritoneal cavity, enlargement of the liver, gaseous distention of the stomach and bowels, extraneous masses, and subphrenic abscess. In all these conditions there is elevation of the diaphragm and more or less impairment of mobility. However, subphrenic abscess is differentiated from these other conditions by the elevation of the posterior boundary of the diaphragm which makes it appear flattened, resembling a "plateau." The posterior costophrenic angle is completely obliterated. Occasionally there is noted evidence of fluid and inflammatory changes in the diaphragmatic pleura and adjacent lung, due to lymphatic permeation of the infection through the diaphragm.

The following case illustrates the "plateau sign of subphrenic abscess."

Miss C. C., aged 45 years, was admitted to the Jewish Hospital with clinical and physical findings of pneumonia of the right lung. An x-ray examination of the chest in the dorsal and lateral decubitus position revealed marked elevation of the right diaphragm. The right lung, although decreased in size, appeared to be free from any involvement (Fig. 2-*A*). In the lateral position the right diaphragm was elevated throughout its entire extent, its surface being on the same level with the crest so that it resembled a plateau, while the posterior costophrenic space was completely obliterated (Fig. 2-*B*). Because of the above sign a diagnosis of subphrenic abscess was made. The past history was quite illuminating for it revealed that she had had a cholecystectomy six months previously from which she made an uneventful recovery. After two or three

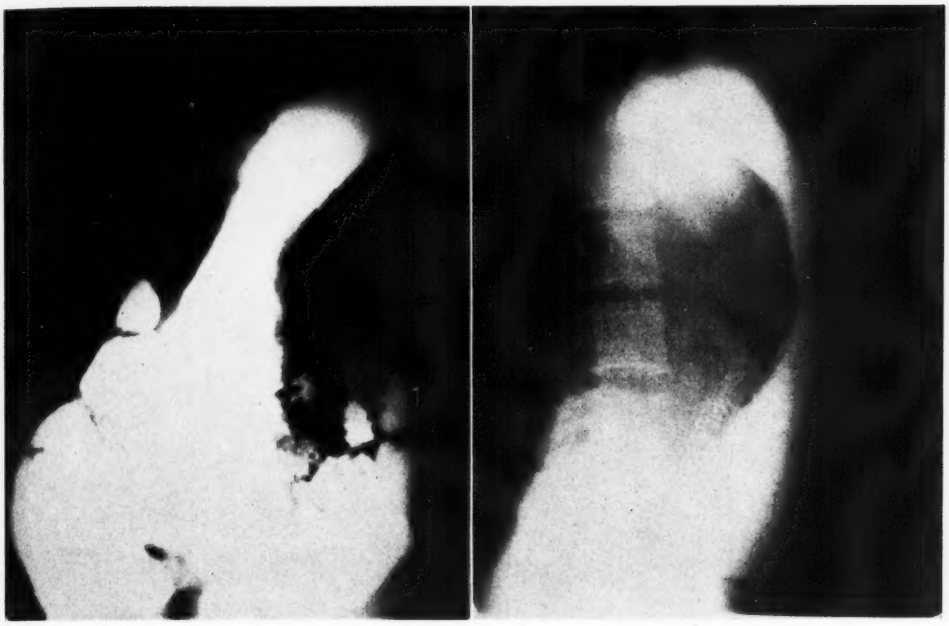

Fig. 3-*A*. Fig. 3-*B*.

Fig. 3-*A*. The stomach is displaced to the right. The greater curvature is compressed by the enlarged spleen. The jejunum and splenic flexure are displaced downward (anterior view).

Fig. 3-*B*. The stomach is displaced forward; the posterior wall is concave as a result of pressure by the enlarged spleen (left lateral decubitus position).

weeks' delay, because of failure to agree upon the diagnosis, the patient was operated upon and a large amount of pus was found in the subphrenic space. Recovery was complete after a stormy convalescence.

Plain Views of the Abdomen.—A plain view of the abdomen in the dorsal or ventral position, and occasionally in the lateral one, should precede the introduction of an opaque medium into any of the hollow viscera. Such views may reveal abnormal dense shadows due to stones in the gall bladder or urinary tract, calcified glands, or metallic foreign bodies; the outline of the liver, spleen, kidneys, and not infrequently, of the gall bladder; the presence of gas in the gastro-intestinal tract and its degree of distention; free fluid or air in the peritoneal cavity, and lastly, extraneous masses in the abdomen. Such an examination will also give one information regarding the skeletal structure.

In the roentgenologic study of the abdomen there is no longer any need to adhere to the classical division into nine regions for identifying the position of the various organs. Such a system was applicable at the time when all our information was chiefly obtained from postmortem studies. The roentgenologic method has enabled us to study the living anatomy which reveals a wide variation within normal limits, depending upon the habitus of the individual, *i.e.*, the age, height, weight, and the position of the body as a whole. Thus it is found that the liver, spleen, kidneys, gall bladder, pancreas, and stomach lie high in the abdominal cavity in the sthenic type and low in the asthenic type or anywhere between these two extremes. There is also a difference in the configuration of the organs in sthenic and asthenic types of individuals. In the former the viscera expand in lateral and anteroposterior directions; in the latter, vertically. Before conclusions are

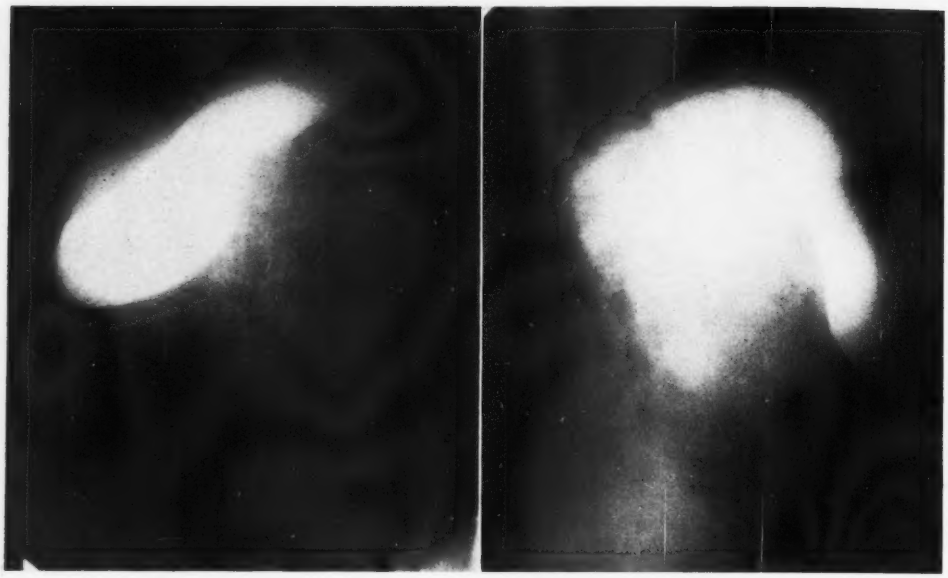

Fig. 4-*A*. Fig. 4-*B*

Fig. 4-*A*. The stomach is displaced upward and to the right. The greater curvature shows a concavity due to pressure by an enlarged left kidney (anterior view).
Fig. 4-*B*. The stomach is displaced forward by the enlarged left kidney (left lateral decubitus position).

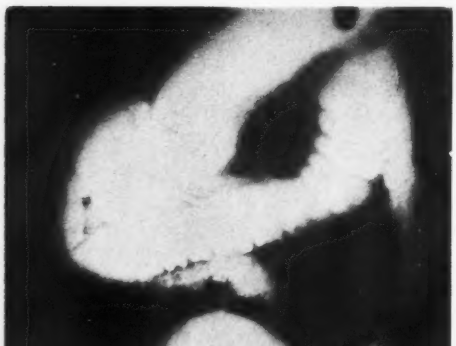

Fig. 4-*C*. The splenic flexure is in normal position, indicating that the "tumor" is not the spleen but a kidney (anterior view).

drawn regarding the position, shape, and size of any organ, the type of individual must be considered. The frequency of diagnosis of "dropped stomach" or "dropped colon" would decrease if the normal anatomical variations were better understood. For the roentgen localization of the position of the organs, we have found it of service to divide the abdomen into four regions by the natural boundaries produced by the spine and iliac crests, with the usual nomenclature (R. U. Q.; L. U. Q.; R. L. Q.; L. L. Q.).

Relationship of the Abdominal Viscera.— While the position, shape, and size of the abdominal viscera depend upon the age, height, weight, habitus, and the posture of the individual, the relationship between them remains constant under normal conditions. This factor of relationship is apparently most important for it is the least altered under normal conditions. While variability of the other factors enumerated may be within the limits of normal anatomical variations, alterations in the factor of relationship of organs indicate that there is something abnormal with one or more of the organs.

The roentgenologic study of the inter-

Fig. 5-*A*. Fig. 5-*B*.

Fig. 5-*A*. The stomach is displaced to the right by a mass in the left hypochondrium (anterior view).
Fig. 5-*B*. The stomach is displaced forward; the posterior wall is deformed and attached to the mass. This was proven to be due to a sarcoma arising from the posterior wall of the stomach (left lateral decubitus position).

relationship between the abdominal viscera has been described previously (2, 3, 4, and 5), so that only a brief review is necessary. In the anterior position, the stomach lies in the left upper quadrant, either transversely or vertically or anywhere between these two extremes, depending upon the habitus of the individual and the position of the body. Thus in the sthenic type, the transverse position prevails while in the asthenic, the vertical. The duodenum is found in the right upper quadrant, its exact position being determined by the location of the pylorus. The jejunum usually occupies the left side of the abdomen, the ileum, the right. The colon is located at the periphery with the usual normal variations. The spleen is located to the left and behind the stomach. The left kidney is located to the left of the spine, behind the stomach and inferior to the spleen. The splenic flexure lies below the spleen and at times under the left diaphragm. The liver is located in the right upper quadrant, its left lobe extending to the left and in front of the stomach. The location of the gall bladder is determined by the position of the pylorus and duodenum. The right kidney lies to the right of the spine behind the liver. The pancreas extends transversely from the duodenal loop to the spleen behind the stomach. The pelvic organs, pelvic colon, sigmoid flexure, and rectum lie in the lower quadrants.

In the right lateral decubitus position, the stomach occupies the anterior part of the abdomen, its anterior wall being parallel with the abdominal wall, and its posterior wall with the spine. The distance between the spine and posterior wall of the stomach varies according to the habitus of the individual, being greater in the sthenic type and less so in the asthenic. The distance between the spine and posterior wall of the stomach gives an indication

Fig. 6-*A*. Fig. 6-*B*.

Fig. 6-*A*. The stomach is displaced to the left by a mass in the epigastrium (anterior view).
Fig. 6-*B*. The stomach is displaced backward; the posterior wall is concave due to pressure by a tumor in front of it. This was proven to be due to a tumor of the left lobe of the liver (right lateral decubitus position).

as to the size of the pancreas. The direction of the pylorus is backward and upward, located between the posterior wall of the stomach and the spine. The duodenal bulb is above the pylorus, and the descending duodenum is parallel to the spine and is rather fixed.

In the left lateral decubitus position the direction of the stomach is from above, downward and forward. The degree of inclination depends upon the habitus of the individual, being almost perpendicular to the spine in the sthenic type and parallel in the asthenic type, or anywhere between these two extremes.

Mobility of the Gastro-intestinal Tract.— The stomach and intestines are, relatively speaking, freely movable, so that their position and shape will depend upon the neighboring organs and the position of the body. Shifting of the stomach and intestines under normal and abnormal conditions generally takes place in a definite order, a knowledge of which will enable one to differentiate the origin of tumors.

Several cases have been chosen to illustrate the various shiftings of the stomach and bowels as a result of abnormal changes in the neighboring organs.

Enlargement of the spleen tends to dislodge the stomach to the right in the ventral decubitus position (Fig. 3-*A*) and forward in the left lateral decubitus position (Fig. 3-*B*), the splenic flexure being displaced downward. Frequently there is a considerable concavity in the lateral wall of the stomach because of pressure by the spleen.

Enlargement of the left kidney displaces the stomach to the right (Fig. 4-*A*) and frequently upward in the ventral decubitus position, and forward in the left lateral decubitus position (Fig. 4-*B*). It is differentiated from splenomegaly by the normal position of the splenic flexure (Fig. 4-*C*).

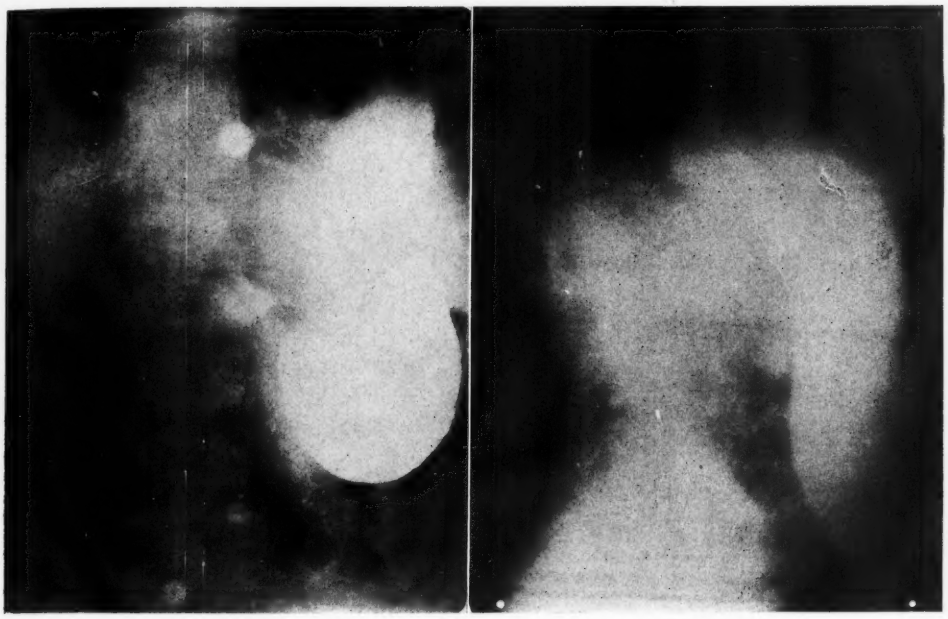

Fig. 7-*A*. Fig. 7-*B*.

Fig. 7-*A*. The stomach and duodenum are displaced to the left by a mass in the right lumbar region (anterior view).

Fig. 7-*B*. The stomach and duodenum are displaced forward due to a large right kidney (right lateral decubitus position).

Tumors in the left upper quadrant arising from the tail of the pancreas or posterior wall of the stomach will displace the latter to the right and forward, the exact origin of the tumor, however, being often difficult to determine. The following case illustrates some of the difficulties which may occur in the diagnosis of a retrogastric tumor.

Mr. N. F. was referred for a gastrointestinal examination because of gastric symptoms. The plain view revealed a large circular mass in the left upper quadrant. After the ingestion of barium the stomach was found to be displaced to the right in the ventral decubitus position (Fig. 5-*A*) and forward in the left lateral decubitus position (Fig. 5-*B*). The posterior wall of the stomach was deformed and apparently attached to the tumor. Such a displacement of the stomach could be induced by a spleen, left kidney, tumor of the tail of the pancreas, or a retrogastric tumor. The left kidney was excluded since its outline was readily seen in the plain view. It was not enlarged, but displaced downward. The spleen was excluded in spite of all the clinical and surgical arguments to the contrary. It has been our experience that when a spleen enlarges it still retains its usual shape, but in this case the mass was more or less circular. Furthermore, in no instance has there been observed a deformity in the contour of the posterior wall of the stomach as a result of an enlarged spleen. The diagnosis was, therefore, a retrogastric tumor attached to the posterior wall of the stomach so that a partial gastrectomy had to be performed. The pathologic diagnosis was a spindle-cell sarcoma arising from the posterior wall of the stomach.

Enlargement of the liver dislodges the stomach to the left in the ventral decubitus position (Fig. 6-*A*) and backward in the right lateral decubitus position (Fig. 6-*B*). The hepatic flexure is displaced downward. In cases in which both the liver and the spleen are enlarged, the

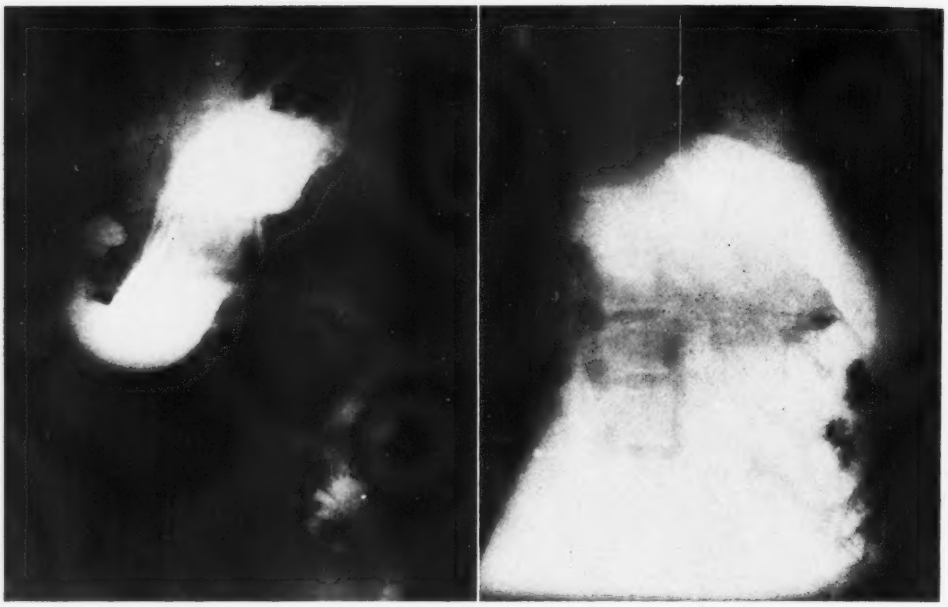

Fig. 8-*A*. Fig. 8-*B*.

Fig. 8-*A*. The stomach is displaced to the right. In the middle of the stomach the barium is absent, due to pressure by a mass in front of the spine (anterior view).
Fig. 8-*B*. The stomach is displaced forward by a mass behind. This was proven to be due to a pancreatic cyst (left lateral decubitus view).

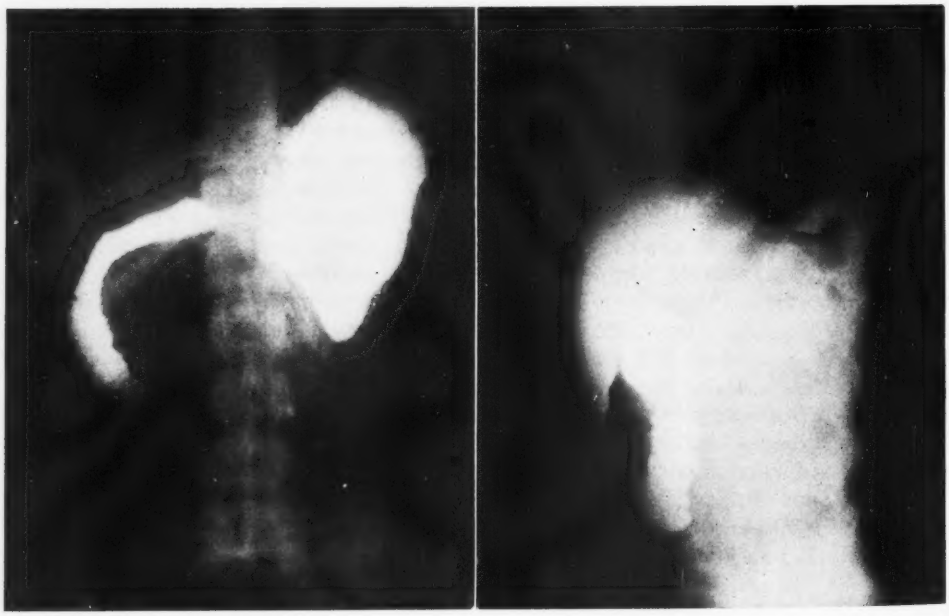

Fig. 9-*A*. Fig. 9-*B*.

Fig. 9-*A*. The stomach is displaced to the left and the duodenum to the right side (anterior view).
Fig. 9-*B*. The stomach and entire duodenum are displaced forward, indicating a glandular tumor which retrogressed under x-ray treatment (right lateral decubitus view).

Fig. 10-*A*. Fig. 10-*B*.

Fig. 10-*A*. The stomach is displaced to the left and duodenum to the right by a mass in front of the spine (anterior view).

Fig. 10-*B*. The stomach and duodenal bulb are displaced forward, but the descending portion is in normal position. This indicates that the tumor is within the duodenal loop, hence a pancreatic tumor (right lateral decubitus view).

position of the stomach may remain more or less unaltered due to opposite forces acting upon each other. The stomach becomes narrowed and elongated.

An enlarged right kidney displaces the stomach to the left in the ventral decubitus position (Fig. 7-*A*) and forward in the right lateral decubitus position (Fig. 7-*B*). The hepatic flexure is usually displaced downward but occasionally it may be upward.

An intragastric tumor does not affect the position of the stomach unless there are also retrogastric or liver metastases. This fact is of aid in distinguishing between an intra- and an extra-gastric tumor. A case presenting a deformity in the contour of the stomach in the anteroposterior view should be examined both in the left and right lateral positions. If the deformity of the stomach is due to an intragastric tumor, its position will be found to be normal with the deformed contour either in the anterior or posterior walls. If the deformity in the anteroposterior view is due to an extra-gastric tumor, the stomach will be found displaced either forward or backward in the lateral positions according to the location of the tumor.

Unlike the liver, spleen, and kidneys, the pancreatic shadow can hardly ever be differentiated upon the film. Nonetheless, the study of the pancreas in relation to the stomach both in the anterior and lateral positions has shown that it is often possible to make an accurate diagnosis of a tumor in cases in which even the clinical and physical findings have failed to suggest its presence.

The effect of a pancreatic tumor upon the position of the stomach and duodenum will depend upon the particular portion of the pancreas involved. Thus a tumor of the head will displace the duodenal bulb and pylorus forward in the right lateral position, and occasionally evidences of

obstruction in the duodenum are noted. In the anterior position, the pylorus may be pushed to the left and the duodenum to the right. A tumor arising from the body of the pancreas will displace the stomach forward, while the duodeno-jejunal flexure may be found displaced downward, and often partially obstructed. A tumor arising from the tail of the pancreas will displace the stomach forward and at times to the right, depending upon its size.

The following case illustrates a tumor of the body of the pancreas. In the anterior decubitus position there was noted displacement of the barium from the middle of the stomach opposite the spine, apparently due to pressure (Fig. 8-*A*). In the right lateral decubitus position (Fig. 8-*B*), the stomach was displaced forward, and no deformity of contour was noted. It was felt that the tumor had its origin in the pancreas, as an intragastric tumor would show a constant deformity in contour and would not have displaced the stomach. Laparotomy disclosed a pancreatic cyst.

Retroperitoneal Tumors.—In retroperitoneal tumors located in front of the spine, the stomach is generally displaced to the left and the duodenum to the right. It is often difficult to differentiate between a neoplasm originating from the pancreas or from the retroperitoneal glands. Evidence of a lesion elsewhere in the body is suggestive of metastases in the retroperitoneal region. The diagnosis is more certain if the mass is affected by roentgen therapy. Forward displacement of the stomach and the entire duodenum indicates a glandular origin of the tumor. The following case illustrates this point.

In the anterior decubitus position (Fig. 9-*A*), the stomach is displaced to the left and the duodenum to the right. The duodenum is noted to make quite a circle around the tumor. In the right lateral decubitus position (Fig. 9-*B*), the stomach and duodenum are displaced forward. Because of the above findings it was felt that this tumor had its origin in the retroperitoneal glands, and roentgen therapy produced rapid retrogression of the neoplasm. On the other hand, in the following case the anterior view also shows displacement of the stomach to the left and the duodenum to the right (Fig. 10-*A*), but unlike the latter the descending portion remains in normal position and only the pylorus and duodenal bulb are dislodged forward in the right lateral decubitus position (Fig. 10-*B*). Evidently the tumor is located within the duodenal loop and hence must be due to a pancreatic tumor of the head. Upon operation, this was found to be the case.

Tumors having their origin in the pelvis usually displace the large and small bowel upward and laterally.

The Stomach and Intestines.—The stomach and intestines are three dimensional structures and, as such, must be studied both in the anteroposterior and lateral positions. Furthermore, as frequently happens, one segment of the gastro-intestinal tract may overlap a neighboring one, thus obscuring it. When these structures are studied from every angle it is often possible to recognize a lesion which may be overlooked in the usual anteroposterior view. This is especially noted in the sthenic type of stomach, the transverse course of which extends from before backward. Such a position results in foreshortening of the viscus in the anteroposterior view; therefore, a lesion located in the middle of the stomach may be obscured and escape detection. In this type of stomach the duodenal bulb is often found behind the pylorus. In the right lateral position the duodenal bulb is visualized and any lesion can be recognized.

In the colon, because of the numerous flexures, various segments may be superimposed and deformities may be obscured in the anteroposterior position. By the study of the colon at various angles it is often possible to separate the segments from one another and bring into view any abnormality present.

SUMMARY AND CONCLUSION

A general survey of the roentgenologic method as applied to the examination of the abdomen is presented.

(1) The importance of the study of the diaphragm in the anteroposterior and lateral positions in relation to abdominal lesions is emphasized. Consideration is given to the "plateau sign" in subphrenic abscess, which consists in the elevation of the diaphragm not only as a whole, but also in its posterior half to the same level as that of the crest, with complete obliteration of the posterior costophrenic angle.

(2) Attention is called to the usefulness of the study of the plain views of the abdomen in the anteroposterior and lateral positions. Many lesions can be recognized outright. The presence of abnormal dense shadows and their relation to the abdominal organs can be determined with a fair degree of accuracy.

(3) A study of the position, shape, size, and relationship of the stomach and bowels reveals the fact that the factor of the relationship is the least variable under normal conditions. Any departure from the normal relationship usually indicates an abnormal change within the abdomen.

(4) Consideration is given to the mobility of the stomach and bowels, their position and shape being influenced by the position of the body as a whole and the neighboring organs. It is pointed out that any shifting of the gastro-intestinal tract takes place in an orderly manner both under normal and abnormal conditions, so that a knowledge of these movements may aid in locating and differentiating the origin of a tumor.

(5) The value derived from a study of the gastro-intestinal tract in various positions of the abdomen is stressed, for it is pointed out that in the usual anteroposterior view the involved portion of the organ may be obscured by foreshortening or overlapping of the viscera.

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DISCUSSION

DR. LEO G. RIGLER (Minneapolis, Minn.): This is a very interesting presentation. I have personally been interested in this type of work for a number of years. I just want to bring out a few points that have appealed to me.

In teaching anatomy students, we try to present the normal roentgen anatomy to correlate with the studies which they are making in their first year in school. I know of no better way to present graphically the topographic anatomy of the abdomen than to use a series such as Dr. Brown has presented.

Now I find that in dissecting the cadaver, the student has great difficulty in orienting in his mind these relationships between the various organs, but by means of adequate roentgen examination in a variety of positions, particularly in cases in which there is a moderate or even extreme enlargement of any of these organs, one can present to the student a remarkable picture of the relationship between the solid organs of the abdomen and the hollow viscera.

There are just a few points in the surgical diseases of the abdomen that it seems to me have never been sufficiently appreciated in this country. Many years ago Laurell described a sign of peritonitis which we have used with considerable success in many cases and it depends, again, upon a realization of the relationships of the intra-abdominal structures.

In peritonitis there is almost invariably an ileus, so that one gets, without the addition of an opaque substance, a clear visualization of the intestinal tract by reason of the gas within it. In addition, in peritonitis there is almost invariably an accumulation of free fluid to some degree

and one can demonstrate this clearly by the separation of the loops of the bowel because of the entrance of this fluid in between these loops.

In occasional cases, the type of obscure or difficult case that Dr. Brown has demonstrated, this sign has been to us one of considerable value. Likewise in cases of intra-abdominal hemorrhage, when there is some doubt as to whether a hemorrhage is present, the demonstration of a displacement of the stomach (and the stomach can be demonstrated without barium because of the gas content within it) from the left diaphragm by what appears to be a mass but which, in fact, is simply an accumulation of blood, particularly if films are made with the patient in the Trendelenburg position, will often help a great deal in elucidating the type of process which is present.

There is only one point that has appealed to me insofar as the diagnosis of these lesions of the head of the pancreas or of the group of peri-aortic lymph nodes upon which Dr. Brown spent some time. That is, one has to be very careful in interpreting an enlarged loop of the duodenum as indicating an enlargement either of the head of the pancreas or of the retroperitoneal nodes. In the hypersthenic type of habitus, an examination made in the supine position is likely to give us that appearance of an enlarged loop under absolutely normal conditions because of the normal fixation of the duodenum and the mobility of the stomach. So that we have to judge the enlargement of the loop entirely by the upright position; otherwise we may be led into error. If the loop is really enlarged with the patient in the upright position, I think it is a very great significance.

I enjoyed Dr. Brown's paper very much —it is such a good review of this type of work.

CASE REPORTS

ENLARGEMENT OF ONE STERNOCLAVICULAR ARTICULATION: A SIGN OF CONGENITAL SYPHILIS[1]

By L. GRANT GLICKMAN, M.D.,
and
ARMEN A. MINSKY, M.D.,
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In 1930, a new sign in the diagnosis of congenital syphilis was first described by Higoumenakis (1), namely, the unilateral enlargement of the sternoclavicular articulation. The authors wish to present another case in addition to those previously described in the literature.

CASE REPORT

A white male, aged 56 years, presented himself to the clinic complaining of a severe sore throat which had been present for the past two months and was becoming progressively worse. The physical examination was essentially negative, with the following exceptions: The patient is left-handed. The pharynx, uvula, and soft palate were injected. Deep serpiginous ulcerations were noted on the posterior surface of the uvula, extending on to the soft palate. These ulcerated areas were dark gray in color, having a thick tenacious exudate. The otolaryngologist concluded that the throat involvement was of syphilitic origin. Inspection of the thorax revealed an enlargement of the sternal end of the left clavicle; palpation and comparison with the opposite side revealed a definite thickening of this area (Fig. 1).

Roentgen examination revealed a prominence at the sternal end of the left clavicle (Fig. 2); that of the right clavicle was normal in size. The radiologic conclusion was enlargement of the sternal end of the left clavicle, apparently a manifestation of congenital syphilis.

Serologic examination upon two occasions revealed a three plus Kahn and a negative Wassermann test. Dark field examination was negative for *Spirochæta pallida*.

Past History.—The patient gave a history of gonorrhea approximately 25 years previously. There was no history of any syphilitic infection and the patient had been well up to the present time, except for an attack of lumbar myalgia four years previously.

[1] Published with the permission of the Medical Director of the Veterans Administration who assumes no responsibility for the opinions expressed or the conclusions drawn by the authors.

Fig. 1. Enlargement of the sternal end of the left clavicle.

Family History.—The patient's father died of a cardiovascular (?) disease at the age of 38 years. His mother was also dead, cause unknown; he had no brothers or sisters. The patient has been married for the past 15 years; there was no history of pregnancies or miscarriages.

Progress.—Intensive antisyphilitic treatment was instituted, and after a period of three weeks the throat had become practically clear of the ulcers and had lost its normal redness.

DISCUSSION

In the original report by Higoumenakis, he described 23 cases of enlargement and anteroposterior thickening of the sternal end of the clavicle. Seven presented this stigma and no other signs of the disease except a positive Wassermann test, while the remaining 16 cases presented this sign with a negative Wassermann test. In a total of 197 cases of congenital syphilis, he found this sign present in 170; 157 involved the right side, while the remaining 13 involved the left side. Stokes (2), Plishkin (3), and Dorne and Zakon (4) all reported similar findings, with the involvement being on the right side.

The enlargement is readily noted upon inspection and palpation, and is frequently found upon roentgen examination. It is usually unilateral and is present on the right side, except in left-handed persons, in whom it occurs on the left side. The explanation of the development of the exostosis is based upon anatomic, biologic, and mechanical factors. The sternal end of the clavicle first consists of connective tissue and is early transformed into osseous tissue. The spirochetes (*Spirochæta pallida*) carried in the blood stream of the fetus, become lodged in the connective tissue, as in the lymphatic tissues and other organs of the fetus. Here they may remain without any

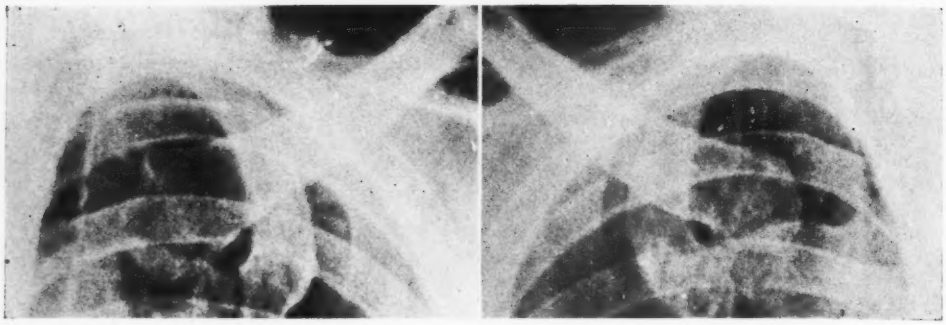

Fig. 2-*A*. Fig. 2-*B*.

Fig. 2-*A*. Roentgenogram of the sternal end of the left clavicle.
Fig. 2-*B*. Sternal end of the right clavicle in contrast to Figure 2-*A*.

manifestations during childhood. Later in life, when the arms are called upon to do heavy work, the frequent movement of the arms and the constant friction of the clavicle against the sternum set up an irritation. The spirochetes are reactivated and through their toxins produce a chronic periostitis which results in hyperostosis. The enlargement of the sternal end of the clavicle reaches a permanent stage about the age of puberty and thus becomes a characteristic, permanent stigma of congenital syphilis.

SUMMARY

(1) The literature is reviewed and a case of unilateral enlargement of the sternal end of the clavicle is here presented.

(2) This was found on the left side in a left-handed individual.

(3) This corroborated the findings reported by Higoumenakis.

(4) Serology revealed a three plus Kahn as the only other positive finding.

(5) A discussion of the pathogenesis is here presented.

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A CASE OF CONJOINED TWINS

By SYDNEY V. KIBBY, M.D., *and* O. B. PRATT, M.D., *Los Angeles, Calif.*

This is a report of a case of conjoined twins delivered at the Japanese Hospital of Los Angeles, Aug. 31, 1936, by Dr. T. Ozasa.

The mother is a Japanese woman, 27 years old, married four years. This was her first pregnancy. Her father is dead, the cause not stated. Her mother is living and healthy. She has no brothers or sisters. Her husband is well. There is no history of abnormal births in either the patient's or her husband's family.

Aside from the usual childrens' diseases, she has always enjoyed good health. The pregnancy was normal and labor initiated one week after the expected date. Twins were diagnosed before the onset of labor.

The first twin started to deliver as a breach, but proceeded only as far as the pelvis when progress was arrested. Attempting to extract an arm or palpate the shoulder, the obstetrician found his hand obstructed by what felt like placenta, but which ruptured, allowing bowel to escape. Discovering then that the twins were joined together and that the birth by the vaginal route was impossible without destruction of both, he did a Cæsarean section and delivered the joined twins through the abdomen.

The mother has made an uneventful recovery with only a slight residual pyelitis.

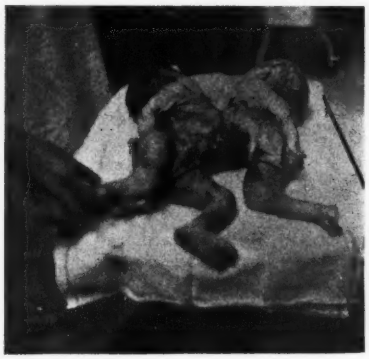
Following are the reports of the radiographs and of the autopsy.

Radiographs taken after delivery of joined twins show an absence of the bones of the right lower limb of one twin. The lumbar vertebræ and sacral segments of this twin are less developed than the corresponding bones of the other. The sternum of the latter twin is missing. The sternum of the one-legged twin shows the normal six segments, the three

lower curving upward toward the breast of its fellow.

General Examination.—The specimen consists of infant twins which are joined together on the ventral surfaces, the junction extending from the fourth rib to the level of the umbilicus. On the surface of the junction of the two, there is an area 6 cm. in diameter where the abdominal cavity is covered by a shiny, semitransparent membrane. This membrane has been ruptured, and sutured together. The attachment of the umbilical cord is at one margin of this area. The heads and upper extremities are normal in appearance. One fetus has normal lower extremities and normal female external genitalia. The other fetus has one normal-appearing extremity; the other lower extremity is entirely absent. This fetus also has no anal opening and no external genitalia. On the perineum of this fetus there is a soft nodular projection of skin measuring about 1 cm. in diameter. This has no markings by which it can be identified as part of the sexual apparatus. The fetus which has both legs does not have a sternum. The ribs end

Fig. 1. Roentgenogram of conjoined twins.



Figs. 2 and 3. Specimen.

anteriorly in separate cartilages. The fetus with only one lower extremity has a complete thoracic cage, including sternum and ribs.

Body Cavities.—Each fetus has two separate pleural cavities. There is only one pericardial sac, which contains a common heart. There is only one abdominal cavity which is common to both fetuses.

Alimentary Tract.—Each has an esophagus, stomach, and duodenum which are normal in gross appearance. The duodenums are each about 10 cm. in length. They join together forming a common jejunum. This continues for approximately 50 cm., when it divides into two ileums. The one belonging to the more complete fetus extends about 30 cm. to the cecum, where there is a normal-appearing appendix. The colon is about 50 cm. in length and communicates to the outside with a normal anal aperture. There is no marking to distinguish the ileum and colon of the incomplete fetus. The change from the characteristics of the ileum to those of the colon is gradual, and no cecum or appendix can be identified. The colon ends in a blind pouch which is quite high in the pelvis.

Respiratory System.—Each fetus has its trachea, bronchi, and lungs, with all lobes completely separated. There are no significant pathologic changes noted in the respiratory system.

Cardiovascular System.—The pericardial cavity contains a heart which appears to be composed of two hearts joined together at the

apices. There is only one ventricular cavity and there does not appear to be a complete septum separating the ventricle from the auricle. The venæ cavæ and pulmonary veins empty into the common auricle in either fetus, and the aortæ and pulmonary arteries originate at either end of the ventricular cavity. In other respects, the blood circulation does not appear to be abnormal.

Urinary System.—The more complete fetus has two polycystic kidneys, each measuring about 4 cm. in diameter. The ureters lead to a normal-appearing bladder. The incomplete fetus has a collapsed, thin-walled sac in the place of the left kidney. There is a cord in the place of the ureter and no bladder can be demonstrated. This fetus has no structure resembling the right kidney.

Reproductive System.—The more complete fetus has uterus, tubes, and ovaries which are normal in appearance. The incomplete fetus has one small structure which resembles the fimbriated extremity of a uterine tube. There are no other structures which, in any way, resemble genital organs in this fetus.

Microscopic Findings.—Section of soft nodule from perineal region shows vascular, fibrous tissue covered with stratified squamous epithelium. There are a few glands and some hair follicles. This does not resemble any of the external genitalia.

Section of small structure from pelvis shows what resembles the fimbriated end of a fallopian tube.

727 West Seventh St.

THE PRE-OPERATIVE DIAGNOSIS OF CHOLECYSTOCOLONIC FISTULA

By JOSEPH T. DANZER, M.D., Oil City Hospital, *Oil City, Pa.*

Although the pre-operative diagnosis of cholecystocolonic fistula has been previously reported, it is by no means a common finding. Podlasky (4), in reviewing the literature previous to 1935, stated that he was the second observer to report such a case. He credits Judd and Burden (2), whose article appeared in 1925, with being the first to report this condition. Since that time similar findings have been reported in both the American and foreign literature.

The case which we report is unusual, because of the mildness of the patient's symptoms at the time of the rupture of the gall bladder into the colon, and because of the complete filling of the bile ducts, which we have found only once (6) in our search of the literature.

The patient, E. M., white, male, aged 65 years, was referred to us by Dr. H. J. Anderson,

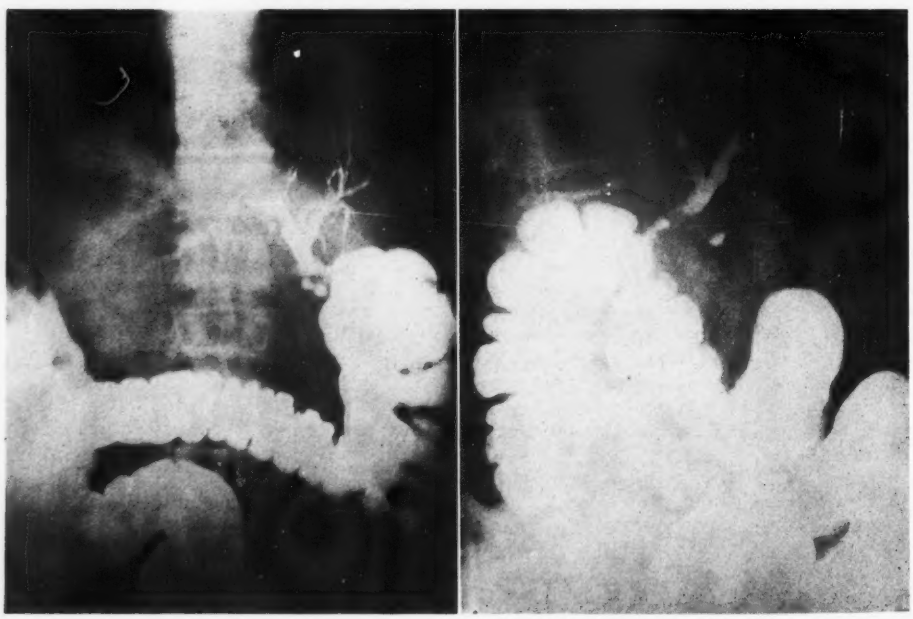


Fig. 1. Film taken immediately after filling the colon, showing the extensive filling of the bile ducts.
Fig. 2. Film taken in the right oblique position, showing in detail the fistulous tract.

Titusville, Pa., for gastro-intestinal examination.

Present Illness.—Two years before admission the patient had a severe attack of what he termed "intestinal flu." At that time he had a high temperature, nausea and vomiting, and a severe diarrhea, having as many as eighteen stools a day. He did not consult a physician, because other members of his family had the same condition, which cleared up in a few days. The patient, however, continued to have the severe diarrhea and at the time he was sent to us was having six to eight stools a day. He stated that he had lost about twenty-five pounds in weight during that time.

Past History.—The usual childhood diseases were mentioned, but no history of any acute illness was elicited. Four years before he had visited a large clinic because of a vague abdominal discomfort, and a gastro-intestinal series was done, but apparently no pathology was seen at that time.

Examination.—On examination of the stomach, and a six-hour plate, no evidence of pathology could be made out. All the barium had left the colon at the end of the 24-hour period.

A barium enema was done, which showed the colon to fill well. The ascending colon was somewhat spastic. No filling defect could be seen at the hepatic flexure. The patient was then turned upon his abdomen and almost instantly the bile ducts became filled with barium.

A careful study of the six-hour examination does show some irregularity at the hepatic flexure, but the true nature of the condition could not be diagnosed from this film.

Air in the bile ducts, which is said to be a diagnostic sign, is not seen on any of these films.

Fig. 3. Film taken after the barium had been expelled from the colon. Practically all the barium has remained in the bile ducts. Some barium was still present in the bile ducts twenty-four hours after this film was taken.

The referring physician reports that the patient's condition has improved considerably under medical treatment; he now has only three stools a day, and has gained in strength and weight. He has thus far refused operation.

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BONE CARCINOMA SECONDARY TO CARCINOMA OF THE URINARY BLADDER

A CASE REPORT

By EDWARD L. JENKINSON, M.D., ARTHUR HUNTER, M.D., *and* EDWARD W. ROBERTS, M.D., *Chicago, Illinois*

From the Department of Radiology, St. Luke's Hospital

Bone carcinoma as a metastatic manifestation of carcinoma elsewhere is initially a lesion of the bone marrow. Piney (1) states:

"At birth all the bones of the skeleton except the cranium contain red marrow in which there is no fatty tissue. The vertebræ, sternum, and os innominata contain red marrow throughout life and only a microscopic amount of fat even in advanced age. The ribs are also storehouses of red cellular marrow throughout life but in advanced age a patch of fatty tissue usually appears at the anterior end of each rib and extends for one inch from the costochondral junction."

This metamorphosis occurs in the long bones in the epiphyses and just below the middle of the shaft and spreads distally more rapidly than proximally, and most rapidly in the distal limb bones. A small patch of red marrow persists in the upper end of each femur and humerus. The vessels of the red marrow are wide and numerous and the velocity of the blood stream is slow. Piney was unable to demonstrate lymphatics in the marrow. He states that metastases are always in the red cellular marrow and showed the presence of

carcinoma cells in endothelial-lined channels, quoting Erbhölz as having shown red blood cells in carcinoma containing endothelial-lined

Fig. 1. Pathologic fracture of right femur due to osteoclastic metastasis from carcinoma of the bladder.

channels. The points of emergence of tumor on bone surface correspond to places of venous exit from the bone.

The site of the earliest deposit is in the medullary cavity at the lower edge of the red marrow in the proximal bones of the limbs and the metastases spread in either direction from their original focus, the proliferation being preceded by an increase in the amount of red cellular marrow. If hyperplasia of the marrow has been evoked by previous anemia the first deposit may be in the lower part of hyperplastic red marrow. The knowledge contributed by Piney favors the embolic origin of osseous metastases. The passage of the pulmonary barrier can be accounted for by the work of Schmidt, who demonstrated the presence of secondary foci in small pulmonary thrombi. These foci may remain latent, only exceptionally disseminating in the systemic circulation.

Carcinoma of the urinary bladder as a primary focus for osseous metastasis is rare if available statistics can be considered as an indication of its frequency. Ewing (2) does not mention it. The overwhelming preponderance of prostatic carcinoma over bladder carcinoma as a cause for metastatic bone lesions is not in the same ratio as the relative incidence of the primary lesions. The more abundant lymphatic supply of the prostate may be a partial explanation for this difference, and the compact situation of the prostate may favor dissemination, whereas the pressure relations in the bladder permit intra-luminal growth which, in consequence, often assumes a papillary character.

H. G. Wells (3) states that Schraut, in 1854, described cases of urinary bladder carcinoma with osseous metastases and that Kastner, in 1908, also described such cases. G. E. Shoemaker (4), in 1911, recorded a case of malignant deposition in the tarsus and metatarsus which developed very rapidly three weeks after thermo-cautery of the bladder tumor. G. E. Pfahler, in 1917, discussed the roentgen diagnosis of metastatic malignant diseases of bone and quoted Fraenkel's work (1911), which was based on 150 cases that died of carcinoma somewhere in the body and in which sagittal sections of the spinal column

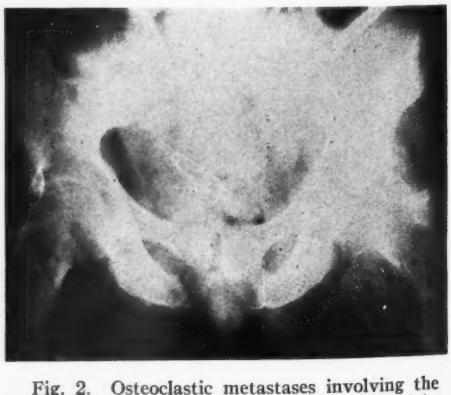

Fig. 2. Osteoclastic metastases involving the inner surface of the proximal third of the right femur and both ischii: primary lesion in the bladder.

were made, followed by roentgenograms. No mention is made of bone metastasis from carcinoma of the bladder.

H. G. Wells reported a case in 1922 in which the presenting complaint was a large sternal tumor which at postmortem examination proved to be a papillary carcinoma secondary to a small carcinoma of the bladder. This patient had had no symptoms referable to the bladder. Wells quotes Wolff as saying that the infrequency of metastasis is due to the paucity of bladder lymphatics. H. L. Kretschmer (5) reported five cases, three of which proved to have osseous and visceral metastases at autopsy. All three had symptoms referable to the osseous involvement. Two other cases are cited which were discovered on radiographic examination.

Cecil A. Joll (6) cited three carcinoma of the bladder specimens and also referred to specimens of metastasis to the radius, the skull, and the tibia in the Museum of the Royal College of Surgeons and in other hospital museums of London.

In 1,032 cases of metastatic malignant lesions in bone studied by Sutherland *et al.* (7) in 1932, nine were due to bladder malignancy. In Geschickter and Copeland's (8) survey of 334 cases of skeletal metastasis, only one was derived from the bladder. In 1934 the Carcinoma Registry of the American Urological Association (9) reported the study of 902 cases of epithelial tumor of the bladder. These cases were collected from varying sources. Thirty-one of the 79 cases coming to autopsy showed metastasis: seven of these showed malignant osseous lesions.

At St. Luke's Hospital two of eight cases of carcinoma of the bladder autopsied in the period from January 1, 1935, to the present [November, 1936], showed osseous metastatic deposits. In the case which follows, attention was first directed to a malignancy of bone by the development of a pathologic fracture of the femur. In the cursory survey of the literature cited above no similar occurrence was noted.

A 65-year-old white male was admitted to the hospital June 8, 1936, on the urological service of Dr. Harry Culver, complaining of hematuria, intermittently present for five years, nocturia of two years' duration, loss of 50 pounds' weight during the past six months, and pain in the right thigh and calf of four months' duration.

Prior to the onset of these complaints the patient's health had been good. The hematuria was intermittent in character, occurring every two or three months, and usually lasting approximately one week. An additional urinary complaint was diurnal and nocturnal frequency, micturition occurring every two or three hours. The most troublesome complaint was that referable to the right lower extremity, which had become progressively more painful and progressively weaker during the four months previous to admission to the hospital. The patient required the use of a cane for walking and at times, when he was in bed, it was necessary for him to move his leg with his hands. The pain had first presented itself in the region of the knee but at the time of admission had extended to the thigh and calf and was present most of the time, both day and night. Other than polydipsia and polyphagia, symptoms referable to the patient's diabetes mellitus, he had no other complaints. The latter condition, in all probability, contributed to the etiology of the frequency of urination, although the patient remained aglycosuric on diabetic management without insulin.

The only physical findings on examination were emaciation, muscular atrophy of the right thigh and calf, edema of the right knee, and palpable crepitus medial to the patella. A tender, fusiform swelling was found along the lateral aspect of the middle third of the right femur.

A cystoscopic examination was made June 9, 1936, at which time a large pedunculated tumor was found attached to the left lateral bladder wall in the region of the left ureteral orifice. The bladder was opened suprapubically on June 11, 1936, and the cystoscopic findings were confirmed. The tumor was found to be a large pedunculated mass of tissue attached to the floor of the bladder in the region of the left ureteral orifice. The wall surrounding the attachment was hard and infiltrated. There was an additional small pedunculated, partly necrotic tumor attached to the floor and posterior wall of the bladder. The tumor mass extended through the bladder wall into the perivesical tissues: 125 grams of tumor tissue were removed by loop resection.

The histologic examination of the tumor tissue was reported as follows by Dr. Edwin F. Hirsch:

"These tissues have the structure of a papillary tumor of the urinary bladder; that is to say, there are papillæ with slender, vascular, fibrous stalks of these epithelial cells with remnants of the stalk structure. Papillary carcinoma of the urinary bladder."

Aside from the development of a moderate secondary anemia, the patient's post-operative course was without complication until the eighth day, when he heard something "crack" as he was raising his right leg in bed. This was accompanied by a marked degree of pain. A portable roentgen examination revealed a pathologic fracture of the right femur due to an

osteoclastic type of metastatic tumor. There was a similar osteoclastic lesion involving the proximal third of the right femur on the medial surface, with involvement of the lesser trochanter. Further roentgen studies at this time indicated similar destructive, osteoclastic lesions involving the left and right ischium. There was no evidence of osseous metastatic lesions of the lumbar spine nor of the left femur.

The fracture was immobilized in a cast and on the twenty-fifth post-operative day the patient was discharged from the hospital.

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EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

THE COLESCOPIC METHOD OF DEMONSTRATING KNOWLEDGE CONCERNING MEDICAL FACTS[1]

The method consists of reproduction of text, drawings, roentgenograms, photographs, and photomicrographs on a strip of moving picture film which may be either projected on a screen or viewed directly by a magnifying apparatus. This method of approach appeals particularly to those who desire to obtain medical knowledge by the visual approach, namely, that of looking at illustrations and reading the captions. This procedure is very popular with those who are pressed for time.[2]

The writer used two subjects to illustrate the method: (1) "The Roentgenological Diagnosis of Ulcer of the Cap," and (2) "The Pathological Diagnosis of Gastric Neoplasm Based on Unorthodox Archeological Microscopic Criteria." Each of these subjects was considered in two distinct presentations. One was a description of the fundamental principles of roentgenologic or pathologic diagnosis, the other an elaborate description of the criteria, amply illustrated with drawings, roentgenograms, and photomicrographs. The text was illustrated with innumerable drawings to convey the writer's conception and exactly the same text described the roentgenograms and photomicrographs which were the source of his knowledge concerning these criteria.

Three of the four presentations shown were so clear and concise that the subject could be understood by physicians who were neither roentgenologists nor pathologists; the clinical significance and application to the medical and surgical treatment of both gastric and cap ulcers became apparent.

The fundamental principles underlying what the writer has called "The Archeologic Approach Based on Unorthodox Microscopic Criteria" were very comprehensive and may have a profound influence on the whole subject of pathology.

The fourth presentation was too elaborate and too comprehensive for an exhibit. It required more time and thought than could be devoted by those attending the meeting, where there was such a wealth of excellent articles on the regular program. In this elaborate presentation the writer submitted text, drawings, and photomicrographs demonstrating 26 unorthodox microscopic criteria of gastric neoplasm which were the direct antithesis of those of simple gastric ulcer, making 52 pathologic findings in all. These were elaborately described by the text and illustrated by 181 drawings and photomicrographs. The drawings conveyed my conception. The photomicrographic findings were submitted in proof of the accuracy of my observations. This demonstration required over two hours to wade through and even then, one would have a desire to go over it again; in answer to the criticism of its being too lengthy I simply stated that it was not even long enough to convey fully the significance of these 26 unorthodox microscopic criteria based on the new archeologic approach.

These films may be viewed individually with a magnifying glass as one would read the text and look at the illustrations of an article in a book or they may be projected upon a screen for the dissemination of this knowledge to medical societies.

The writer also had an incomplete manuscript for the intensive teaching of gastrointestinal roentgenology which will be made available if there is a demand.

This created enough interest so that several authors, Kirklin, Portmann, Glasser, and Rigler among others, agreed to submit material to be reproduced and disseminated in this manner. It is hoped that other investigators may employ this method of circulating scientific knowledge in instances in which a great number of roentgenograms, photographs, photomicro-

[1] Presented at the Cincinnati Meeting of the Radiological Society of North America, Nov. 30–Dec. 4, 1936.

[2] Those who really have significant material to disseminate are urged to communicate with the writer or with the American Medical Films, Inc., a firm which is attempting to produce and distribute this material.

JOHN D. CAMP, M.D., President of the Radiological Society of North America.

graphs, or charts are essential to a proper understanding of the subject or in proof of the clinical results, as in a large series of treatment cases.

LEWIS GREGORY COLE, M.D.

36 East 61st St.
New York City

PRESIDENT JOHN D. CAMP, M.D.

John Dexter Camp, President of the Radiological Society of North America for the ensuing year, is a native of Massachusetts and is 38 years of age. He received the degrees of B.S., Ch.B., and M.D., successively, from Boston University in 1920, 1921, and 1922, respectively. His training in radiology was obtained as a Fellow in The Mayo Foundation from 1922 to 1924. Thereafter he became assistant roentgenologist at Massachusetts General Hospital, entered into private practice in Boston in 1927, and was appointed consulting roentgenologist to The Palmer Memorial, Massachusetts Women's, Leonard Morse and the Westerly (Rhode Island) Hospitals. In 1928 he was called to the post of consultant in the Section on Roentgenology at The Mayo Clinic, where he has since continued. His contributions to the literature have covered a wide range of subjects including the roentgenologic anatomy and pathology of the sella turcica, the diagnosis of tumors of the brain and of the spinal cord, the osseous changes accompanying hyperparathyroidism, and the value of the niche as a diagnostic sign of gastrojejunal ulcer. During his membership in the Radiological Society he has served variously as Assistant Editor of its Journal, and Counselor for the States of Massachusetts and Minnesota. For three years prior to his election to head the Society he was a member of its Executive Committee.

ALBERT MILLER, M.D.

PRESENTATION OF THE GAVEL

Several years ago, Dr. Pfahler presented to the Radiological Society of North America, this gavel. Inscribed upon it are the names of the past Presidents of our Society. It is given to the incoming President each year as a token of esteem which Dr. Pfahler has for his fellow-radiologists. It is also a token of authority and leadership. It affords me a great deal of pleasure to present this gavel to a man who not only possesses leadership, but because of his learning and scholarly achievements is recognized—not only in this country, but abroad—as one of America's leading radiologists. Only last Sunday he arrived in New York, after spending three months in Europe. I do not know what decorations he received from foreign countries, or what habits he acquired—I only hope that he does not expect me to present this gavel to him as they would in France—that is, with a kiss! It gives me a great deal of pleasure to present to Dr. John D. Camp, our new President, this gavel.

THOMAS A. BURCHAM, M.D.

ADDRESS OF THE RETIRING PRESIDENT

CINCINNATI ANNUAL MEETING

As President of the Radiological Society of North America during the past year, I have had an opportunity to become acquainted with a large number of the members and this contact has enabled me to more fully understand the functions, problems, and needs of our Society, and to have a small part in their solution. I am grateful for having been afforded the opportunity of serving you, and I wish to express my appreciation of the honor you bestowed upon me.

The untiring efforts of the entire membership in helping me carry out the duties of this office are acknowledged. Because of the earnest and efficient manner in which each chairman and the individual members of the different committees performed their duties, my responsibilities were lessened. This spirit of co-operation was conducive to a year of happiness long to be remembered.

Never in the history of the Society has its business been more efficiently conducted than at present by the officers and members of the various committees. The sound financial condition of the Society and of RADIOLOGY, our Journal, is shown in the report of the Secretary-Treasurer. This is due to the efficiency of the Executive Committee and the untiring efforts and excellent business judgment of the Secretary-Treasurer, Dr. D. S. Childs.

No single method of diagnosis and treatment of human ailments has shown such a rapid advance during a like period of time as has the x-ray since the date of its discovery. This advancement has been made possible by research and the expenditure of large sums of money by the manufacturers of x-ray appara-

tus. It is now possible to put very efficient x-ray equipment in the hands of a large number of individuals with little or no knowledge of the physics or mechanics necessary to operate the equipment. It is possible with a few hours of instruction for a physician or a technician, to make very good radiographs of the human body. These assertions are not made with the idea of censuring the manufacturers for the wide distribution of x-ray equipment, but are mentioned to show the tremendous advances that have been made. The broad distribution of x-ray equipment has in many instances created in the minds of the lay people, and physicians as well, a desire for competent x-ray examinations. It has acquainted the physicians with the far-reaching possibilities of x-ray examinations in the hands of a trained radiologist.

An important function of the Radiological Society at this time is to acquaint the physician, who is desirous of entering the field of radiology, with the necessity of thorough training and to emphasize his responsibility in this regard. The field of diagnostic radiology is so broad in its application that it is necessary for those desiring to enter this specialty to have not only the fundamental training of the surgeon and clinician, but also a knowledge of the many different specialties. In fact, radiology covers practically all of the specialties, and is now being divided into different specified fields. Unless the training of the young radiologist includes a knowledge of the basic sciences, in addition to a thorough training in clinical medicine, he will not possess the education necessary for success in his chosen field. His training should be such that he can take his place as a consultant along with the surgeon and internist. The training now given in many of our teaching institutions and clinics should be encouraged and continued, keeping these thoughts always foremost: first, that the training leading to qualification as a radiologist is a post-graduate study and qualification can be attained only after years of study and application; second, that radiology must be interwoven into the practice of medicine as a whole; third, that the practice of radiology is the practice of medicine and cannot be separated into professional and technical branches.

The work of the American Board of Radiology is to be commended and its members congratulated on the excellent and unbiased manner in which the examinations have been conducted. The Diplomates of this Board hold in their hands the future destiny of radiology: in a very short time the influence of these men will be paramount in determining the future training in radiology. They will also outline the policies to be adhered to in hospital practice; they will designate the requirements for membership in national x-ray organizations. They are now receiving the recognition of the American Medical Association, which is the only avenue of membership to organized medicine.

Within the last few years the treatment of cancer has been given over to the radiologists, and, as radiologists, we must accept this responsibility. A great deal of confusion exists in the field of x-ray therapy at this time, partly due to the uncertainty as to the quality and quantity of x-ray administered for different specific conditions, and partly due to the many and varied technics now being employed by a large number of radiotherapists throughout the world. This is unavoidable, and as it should be, for from the records of their experiments, and as result of their efforts, will finally emerge the most efficient technic to be employed in the treatment of certain specific conditions to insure the greatest degree of success. Because of the time necessary to accumulate accurate statistics, one is inclined to believe that the clinical application of x-ray has not advanced as rapidly as the development of equipment, but time is a necessary factor in determining results in all treatments. However, with the instruments of precision now available great care can and must be exercised in recording the different factors in the application of x-ray dosage, including complete histories and pathologic reports, with a view to an honest and unbiased report of the results obtained.

During the last few years we have heard a great deal about economic, political, and social changes in the different countries of the world, and we have heard much discussion as to how these changes, if put into effect in this country, would affect the practice of medicine. These discussions have become so general and so frequent that we, as physicians, cannot avoid them if we are to exist as members of organized medicine. We must face these issues.

As a result of the changes which have already taken place, I have stated on more than one occasion that there is a need for unity, even to the point of consolidation of our national radiological organizations. This statement was based on the question of economic

necessity. However, since the change in the attitude of the national x-ray organizations whereby they have undertaken to establish a liaison between the different societies and to correlate their efforts with a division of the teaching, political, and economic problems, I am wavering in this opinion. I feel that the traditional associations established by the national organizations over a long period of years are desirable and should be a cherished memory in the minds of the members of the different organizations.

With a continued spirit of co-operation, and a solidarity of purpose, we can expect advances in the future as great as those which have been made in the past. Revolutionary changes are taking place in reference to the care of the sick and we may expect further changes in the future, whereby the services of the radiologists will be extended to a large percentage of our population who are now denied such service because of their inability to pay. If we can be a part of such a service, and can do our share in the relief and care of sick and suffering humanity, we should welcome such changes for the betterment of society. We must be assured, however, that these changes will not mean that we become subservient to such bureaucratic and lay control as would jeopardize a great and noble profession.

THOMAS A. BURCHAM, M.D.

ANNOUNCEMENTS

REPORT OF THE COMMITTEE ON SCIENTIFIC AWARDS

Annual Meeting, 1936

The Committee on Scientific Exhibit Awards took the following factors into consideration in judging the merits of the exhibit at the Twenty-second Annual Meeting of the Radiological Society of North America:

1. Originality of conception;
2. The personal effort shown in the exhibit;
3. The excellence of technical presentation;
4. The self-explanatory nature of the exhibit;
5. The completeness of the exhibit;
6. Whether this is the first time the exhibit has been shown in whole or in part.

For the first award, we designate Dr. Henry Snure and Dr. George D. Maner for their exhibit entitled "Roentgen-ray Evidence of Metastatic Malignancy in Bone."

For the second award, we were unable to decide between the exhibits of Dr. Edward B. Benedict and Dr. Richard Schatzki, and that of Dr. Rudolph Schlindler and Dr. Frederick Templeton. Consequently, we designate both of them for the second award.

For the third award, we designate Edith H. Quimby, M.A., and Dr. William S. MacComb for their exhibit entitled "Recovery of Human Skin from Irradiation."

For Honorable Mention we designate Dr. Robert H. Millwee, of Dallas, Texas, for his Scanlogram exhibit.

We wish to mention also the excellent exhibit of Dr. Wendell G. Scott and Dr. Sherwood Moore on "Roentgen Kymography," and we wish to thank Dr. Samuel Brown for the instructive and extensive exhibit which he presented to avoid bare spaces in the view boxes.

We should like to express, in behalf of the Society, thanks and appreciation to the participants in this year's exhibit; it has been a distinctly worth-while supplement to the value of our Annual Meeting.

Respectfully submitted,

THE SECRET COMMITTEE.

AWARD OF GOLD MEDALS

In awarding the gold medals of the Radiological Society of North America at the Twenty-second Annual Meeting of the Society, President Thomas A. Burcham spoke as follows:

Eleven years ago Edwin C. Ernst, M.D., and Otto Glasser, Ph.D., were appointed as Chairman and Sub-chairman of the Standardization Committee on X-ray Measurements of the Radiological Society of North America. The members of this Society are familiar with their work, and aware that their efforts to secure the adoption of an international standard of measurement and to develop simple, economical, and practical methods of measuring x-rays have been a potent factor in promoting the greatest advances in the field of x-ray therapy since the invention of the hot cathode tube. Their work has been closely interwoven and it is eminently fitting that this Society in honoring one, should honor both.

Therefore, Edwin C. Ernst, by virtue of the authority vested in me by the Board of Censors

and the Executive Committee of the Radiological Society of North America, I have the honor to present you with the gold medal of the Society in recognition of the following achievements:

You suggested and urged the appointment of a Committee on Standardization of X-ray Measurements in this Society.

As Chairman of that Committee, you promptly recognized the magnitude of your task and applied for help to the United States Bureau of Standards.

Working against almost unsurmountable obstacles, you obtained the interest and enlisted the assistance of those powerful enough to authorize and finance the United States Bureau of Standards in a task which, by its successful accomplishment, has brought great honor to our country among the nations of the world.

By your energy, your unselfish devotion to your purpose, your readiness to compromise and to be content with less than perfection, and your amiable personality, you played a large part in the adoption of an international unit of x-ray measurements.

And to you, Otto Glasser, by virtue of the same authority, I have the honor to present the gold medal of the Society in recognition of the following achievements:

You were probably the first to construct a small ionization chamber whose wall had the same absorption value as air.

You designed, constructed, and have constantly improved a measuring instrument simple enough to be used by any practising radiologist, accurate enough for all practical purposes, and sold at a price within the means of everyone.

As Sub-chairman for many years of the Committee on the Standardization of X-ray Measurements of this Society, you labored unselfishly and modestly. You recognized the great need of medical radiologists for greater accuracy, and in spite of your scientific training, you were content to advance little by little instead of solving the problems assigned to you and your Committee all at one time.

Without ever claiming credit for your own efforts, you played a large part in the adoption of an international unit of x-ray measurement. By your sincerity of purpose, your unselfish devotion to scientific accuracy, and your warm-hearted and lovable personality, you have been able to compose many national and international differences arising in the course of the labors of the International Committee on X-ray Units.

MID-WESTERN RADIOLOGISTS

The first annual Clinical Conference of Midwestern Radiologists is to be held in Rochester, Minnesota, Feb. 12 and 13. All radiologists are invited to attend. Headquarters will be at the Kahler Hotel.

If there is a sufficient number making the trip from Chicago to Rochester, there will be a special train leaving Chicago on Thursday afternoon, February 11.

EASTERN CONFERENCE OF RADIOLOGISTS

An Eastern Conference of Radiologists is to be held in New York City, January 29 and 30, under the sponsorship of the New York Roentgen Society. Headquarters will be at the Hotel Pennsylvania.

Further details can be learned from Dr. E. F. Merrill, 30 West 59th Street, New York City.

THE PROGRAM OF THE FIFTH INTERNATIONAL CONGRESS OF RADIOLOGY

Contributions for the program of the Fifth International Congress of Radiology are now being received. The Congress will be held at the Palmer House, Chicago, Sept. 13–17, 1937.

The rules of the International Congress require that participants in the program be members of the Congress. Announcements setting forth the requirements for membership have been mailed to all members of radiological societies in all countries.

All who wish to take part in the program should apply to the President, Dr. A. C. Christie, 1835 Eye Street, Washington, D. C., stating the subject which they wish to present and at the same time should send their application for membership in the Congress to The Secretary, Fifth International Congress of Radiology, 2561 North Clark Street, Chicago, Illinois.

If possible, the application for place on the program should be accompanied by a 500-word abstract and in any case such abstract must be received by the President not later than April 1, 1937, and the full text of the paper

not later than May 1, 1937. The abstracts will be published in the three official languages of the Congress at least six weeks prior to the meeting of the Congress. The full text will also be translated into the other two official languages and will be projected on the screen in those languages while it is being delivered.

Prompt transmission of the abstract and full text will greatly facilitate the work of translation, publication of the book of abstracts, and preparation of the films for projection.

RADIOLOGICAL SECTION OF THE LOS ANGELES COUNTY MEDICAL ASSOCIATION

At the last meeting of the Radiological Section of the Los Angeles County Medical Association, the following officers were elected to serve for 1937:

President, D. R. McColl, M.D.
Vice-president, John F. Chapman, M.D.
Treasurer, Henry Snure, M.D.
Secretary, E. N. Liljedahl, M.D.

Meetings are held on the second Wednesday of the month at the County Society building.

IN MEMORIAM

RESOLUTION OF THE PHILADELPHIA ROENTGEN RAY SOCIETY CONCERNING THE UNTIMELY DEATH OF WILLIS FASTNACHT MANGES

WHEREAS, our beloved fellow-member, Willis Fastnacht Manges, was taken from us by death on Nov. 24, 1936, and

WHEREAS, we fully appreciate the magnitude of our loss, and desire to express and permanently record our thoughts upon this sad occasion, be it therefore

RESOLVED, that the following statement be spread upon our minutes and a copy sent to the bereaved family of our departed friend.

Willis Manges combined, in rare degree, the qualities of scientist, teacher, physician, and gentleman. Born at Luthersburg, Penna., in 1876, he attended Gettysburg College, then matriculated at Jefferson Medical College and was granted the degree of Doctor of Medicine in 1903. Twenty-five years later (1928) Gettysburg recognized his pre-eminence by bestowing upon him the Honorary Degree of Doctor of Science.

He began the practice of radiology when that specialty was still in its infancy. He can, therefore, be listed as one of radiology's pioneers. From the very beginning of his work he gave evidence of unusual ability along investigative lines. Never content merely to follow the beaten path, he was often the first to try out a new technic or method. Radiologists all over the world are aware of their debt to him, for he not only accomplished fundamental researches, he enriched the scientific literature with many a lucid description of his results. To mention only the more outstanding of his contributions, we call attention to (1) his announcement of the first mathematically accurate method of roentgen pelvimetry, in the "American Quarterly of Roentgenology" for 1911; (2) his introduction of pyeloscopy as an adjunct and control for pyelography, first reported in the "American Journal of Roentgenology" for 1918; (3) his development of an efficient organization at Camp Greenleaf where hundreds of Army Medical Officers were given training in roentgenology under his direction during the World War; (4) his vivid description of the mechanism and diagnostic significance of obstructive emphysema and atelectasis, in connection with foreign bodies and various endobronchial lesions; (5) his work with Chevalier Jackson in the application of biplane fluoroscopy to the problem of recovering foreign bodies from the air and food passages; (6) his successful application of the biplane fluoroscope to the problem of localizing and removing non-magnetic foreign bodies from the eye.

As a teacher, Willis Manges was gentle, lucid, painstaking, and inspiring. Fortunate indeed are those who can say, "I was his understudy." And fortunate was his Alma Mater in her choice of Willis Manges as Professor of Roentgenology.

Willis Manges was first and foremost a physician. He realized from the beginning of his work in roentgenology that the importance of developing technic must not be permitted to turn the physician-roentgenologist into a technician. He warned us, frequently, that we must be physicians first, roentgenologists second. As a Charter Member of the American Board of Radiology his voice was raised in defense of proper standards in this matter.

Finally we pay tribute to Willis Manges the man. The quality of his friendship warmed our hearts. His personal charm will never be

The late WILLIS F. MANGES. M.D.

forgotten. His generosity and unselfishness made the world a better place for us to live in. He set an example to all in his integrity and character. His passing has made us poorer, as his years with us made us richer. We glory in his achievements and will ever cherish the memory of his years in our company.

COMMUNICATIONS

THE SOUTH CAROLINA X-RAY SOCIETY

The first regular fall meeting of the South Carolina X-ray Society was well attended. It was unanimously voted to make it a second regular meeting, the other regular meeting to be at the time and place of the State Medical Association meeting. This fall meeting will always be in Charleston on the first Thursday in November and will coincide with the annual Founder's Day celebration of the State Medical College.

The program on Thursday, Nov. 5, 1936, held in the Medical College of the State of South Carolina, Charleston, S. C., was as follows:

1. A Discussion of Supervoltage Therapy Installations, R. B. Taft, M.D.
2. Treatment of Cancer of the Breast, T. Hutson Martin, M.D., and Augusta Willis, M.D.
3. The Effects of Irradiation on Normal and Abnormal Cells, J. Hampton Hoch, D.Sc.
4. Skin Reactions and Skin Recovery, Hillyer Rudisill, Jr., M.D.
5. The Pathological Grading of Tumors, Thomas Peery, M.D.
6. Microscopic Changes in Tumors Following Irradiation, Harold Wood, M.D.

HILLYER RUDISILL, JR., M.D., *Secretary*

"PLANEOGRAPHY"

I have taken the liberty of coining the term, "planeography." It has been used in two articles: "Planeography, Localization, and Mensuration: 'Standard Depth Curves,' " RADIOLOGY, August, 1936, p. 168, and "The Planeogram: Analysis and Practical Application, with Especial Reference to Mensuration of the Pelvic Inlet," RADIOLOGY, December, 1936, p. 732. It should not be confused with terms such as "planigraphy," "tomography," "stratigraphy," etc. "Planeography" refers to the differentiation of *all* the individual planes of which an object is composed from two "ordinary" roentgenograms. The method has been extended to embrace the entire field of localization and mensuration. The other terms refer to a procedure which distorts all the points of an object except those in *one* particular plane. The points in this one plane appear in the roentgenogram: all the other points are effaced. Each procedure has its field of usefulness and limitation: each is entirely different from the other in method and in scope. Different appellations are warranted.

JULIUS KAUFMAN, M.D.

DIPLOMATES OF THE AMERICAN BOARD OF RADIOLOGY

December 31, 1936

The following is a complete list of the radiologists who have appeared before the Board and passed a satisfactory examination in the field indicated.

	Name	Address	Field
1.	Ackemann, H. W.	Rockford, Ill.	Radiology
2.	Adair, Frank E.	New York, N. Y.	Therapeutic Radiology
3.	Albert, Simon	Providence, R. I.	Radiology
4.	Alexander, F. K.	Philadelphia, Pa.	Radiology
5.	Allen, B. M.	Wilmington, Del.	Diagnostic Roentgenology
*6.	Allen, Bundy	Tampa, Fla.	Radiology
7.	Allen, Kenneth D. A.	Denver, Colo.	Radiology
8.	Allen, Lewis G.	Kansas City, Kans.	Radiology
9.	Allen, M. Lowry	Philadelphia, Pa.	Radiology
10.	Allen, William E., Jr.	St. Louis, Mo.	Roentgenology
11.	Alley, Reuben G.	Pittsburgh, Pa.	Diagnostic Roentgenology
12.	Allison, R. G.	Minneapolis, Minn.	Roentgenology
13.	Altman, W. S.	Quincy, Mass.	Radiology
14.	Ames, Forrest B.	Bangor, Me.	Roentgenology
15.	Anderson, W. D.	Memphis, Tenn.	Roentgenology
16.	Andrews, J. Robert	Cleveland, O.	Radiology
17.	Ané, J. N.	New Orleans, La.	Radiology
18.	Anspach, William E.	Chicago, Ill.	Roentgenology
19.	Archer, Vincent W.	University, Va.	Roentgenology
20.	Arens, Robert A.	Chicago, Ill.	Radiology
21.	Arneson, A. N.	St. Louis, Mo.	Therapeutic Radiology
22.	Ashbury, Howard E.	Baltimore, Md.	Radiology
23.	Atkins, S. M.	Waterbury, Conn.	Roentgenology
24.	Aurelius, J. Richards	St. Paul, Minn.	Roentgenology
25.	Avery, Philip S.	New Brunswick, N. J.	Roentgenology
26.	Bachman, M. H.	Youngstown, O.	Roentgenology
27.	Bacon, Ralph D.	Erie, Pa.	Radiology
28.	Bader, E. R.	Cincinnati, O.	Radiology
29.	Bailey, C. O.	Los Angeles, Cal.	Therapeutic Radiology
30.	Bailey, Wilbur	Pasadena, Cal.	Radiology
31.	Baker, Charles F.	Newark, N. J.	Roentgenology
32.	Baker, Edgar C.	Youngstown, O.	Radiology
33.	Ball, Clarence F.	Rutland, Vt.	Therapeutic Radiology
34.	Ball, Robert P.	Chattanooga, Tenn.	Roentgenology
35.	Barfield-Carter, M.	Birmingham, Ala.	Roentgenology
36.	Barker, Walter C.	Philadelphia, Pa.	Radiology
37.	Barker, W. Allen	Petersburg, Va.	Roentgenology
38.	Barnes, John M.	Buffalo, N. Y.	Roentgenology
39.	Barnett, Arthur F.	Eugene, Ore.	Radiology
40.	Barr, Richard E.	Beaumont, Tex.	Therapeutic Radiology
41.	Barrow, S. C.	Shreveport, La.	Radiology
42.	Barth, Earl E.	Chicago, Ill.	Roentgenology
43.	Bauer, August A.	Chicago, Ill.	Roentgenology
44.	Baum, Samuel M.	New York, N. Y.	Therapeutic Radiology
45.	Baxter, O. D.	Sumter, S. C.	Radiology
46.	Beals, John A.	Greenville, Miss.	Radiology
47.	Beeler, Raymond C.	Indianapolis, Ind.	Radiology
48.	Beilin, D. S.	Chicago, Ill.	Radiology
49.	Bell, A. L. L.	Brooklyn, N. Y.	Roentgenology
50.	Bell, J. C.	Louisville, Ky.	Roentgenology
51.	Bendick, Arthur J.	New York, N. Y.	Radiology
*52.	Benishek, Werner L.	Aurora, Ill.	Roentgenology
53.	Benjamin, Emanuel W.	Providence, R. I.	Radiology
54.	Berg, H. Milton	Bismarck, N. D.	Radiology
55.	Bernath, Gerald J.	Detroit, Mich.	Diagnostic Roentgenology
56.	Bernstein, J. H.	New York, N. Y.	Radiology
57.	Bethea, W. R.	Memphis, Tenn.	Roentgenology
58.	Betts, Arthur	Spokane, Wash.	Radiology
59.	Birdsall, Edgar	Glens Falls, N. Y.	Diagnostic Roentgenology
60.	Birkelo, C. C.	Detroit, Mich.	Roentgenology
61.	Bishop, Paul A.	Philadelphia, Pa.	Radiology
62.	Blackett, Charles W.	Boston, Mass.	Roentgenology
63.	Blaine, Edward S.	Los Angeles, Cal.	Roentgenology
64.	Blake, T. W.	Rochester, Minn.	Radiology
65.	Bliss, Gerald D	Altoona, Pa.	Radiology
66.	Bloom, Arthur R.	Detroit, Mich.	Diagnostic Roentgenology

*Deceased.

67.	Bogan, Isabel K.	Brookline, Mass.	Roentgenology
68.	Bogan, Mary E.	Brookline, Mass.	Roentgenology
69.	Bogart, Franklin B.	Chattanooga, Tenn.	Roentgenology
70.	Bonnar, James M.	New Bedford, Mass.	Radiology
71.	Bonoff, Karl M.	Los Angeles, Cal.	Diagnostic Roentgenology
72.	Borman, C. N.	Minneapolis, Minn.	Radiology
73.	Borzell, F. F.	Philadelphia, Pa.	Radiology
74.	Bowen, Carl B.	Oakland, Cal.	Roentgenology
75.	Bowen, David R.	Philadelphia, Pa.	Radiology
76.	Bowing, Harry H.	Rochester, Minn.	Therapeutic Radiology
77.	Boyd, James F.	Providence, R. I.	Radiology
78.	Boyes, James G.	Plainfield, N. J.	Roentgenology
79.	Bradley, Robert A.	Atlantic City, N. J.	Radiology
80.	Brams, Julius	Chicago, Ill.	Radiology
81.	Brandenburg, H. P.	Denver, Col.	Radiology
82.	Brenneman, R. E.	Meadville, Pa.	Radiology
83.	Bridenbaugh, J. H.	Billings, Mont.	Radiology
84.	Broeser, Henry V.	Hoboken, N. J.	Diagnostic Roentgenology
85.	Bromer, Ralph S.	Bryn Mawr, Pa.	Radiology
86.	Brooksher, W. R.	Fort Smith, Ark.	Radiology
87.	Brouse, Ivan E.	Jacksonville, Ill.	Roentgenology
88.	Brown, H. O.	Tampa, Fla.	Roentgenology
89.	Brown, Percy	Boston, Mass.	Roentgenology
90.	Brown, Samuel	Cincinnati, O.	Roentgenology
91.	Bruck, Samuel	Philadelphia, Pa.	Radiology
92.	Bryan, Lloyd	San Francisco, Cal.	Roentgenology
93.	Burch, Hobart A.	Elmira, N. Y.	Radiology
94.	Burcham, Thomas A.	Des Moines, Ia.	Radiology
95.	Burnett, H. W.	Dayton, O.	Roentgenology
96.	Butler, Nicholas G.	Hartford, Conn.	Radiology
97.	Butler, P. F.	Boston, Mass.	Radiology
98.	Caldwell, Charles S.	Pittsburgh, Pa.	Roentgenology
99.	Camp, John D.	Rochester, Minn.	Roentgenology
100.	Capp, Charles S.	San Antonio, Tex.	Radiology
101.	Carlson, Glenn D.	Dallas, Tex.	Roentgenology
102.	Carr, Edson W.	Chicago, Ill.	Diagnostic Roentgenology
103.	Carter, Ray A.	Los Angeles, Cal.	Roentgenology
104.	Carty, John R.	New York, N. Y.	Radiology
105.	Case, James T.	Chicago, Ill.	Radiology
106.	Cathcart, John W.	El Paso, Tex.	Radiology
107.	Challenger, Chester J.	Chicago, Ill.	Roentgenology
108.	Chamberlain, W. Edward	Philadelphia, Pa.	Radiology
109.	Chapman, John F.	Pasadena, Cal.	Roentgenology
110.	Childe, Arthur E.	Montreal, Que.	Diagnostic Roentgenology
111.	Childs, D. S.	Syracuse, N. Y.	Roentgenology
112.	Childs, S. B.	Denver, Colo.	Roentgenology
113.	Chilko, A. J.	New Rochelle, N. Y.	Roentgenology
114.	Christie, Arthur C.	Washington, D. C.	Radiology
115.	Cilley, Earl I. L.	Bellingham, Wash.	Radiology
116.	Claiborne, E. M.	New York, N. Y.	Radiology
117.	Clark, D. M.	Santa Barbara, Cal.	Radiology
118.	Clark, James J.	Atlanta, Ga.	Roentgenology
119.	Clark, Stanley A.	South Bend, Ind.	Radiology
120.	Clarkson, Wright	Petersburg, Va.	Radiology
121.	Cleaves, Edwin N.	Boston, Mass.	Diagnostic Roentgenology
122.	Cleghorn, Charles D.	Miami, Fla.	Radiology
123.	Clement, Gage	Duluth, Minn.	Radiology
124.	Cleveland, W. R.	Evansville, Ind.	Radiology
125.	Coate, J. D.	Oakland, Cal.	Radiology
126.	Coe, Fred O.	Washington, D. C.	Radiology
127.	Coffin, Whitman K.	Boston, Mass.	Roentgenology
128.	Cohoon, Carl W.	Bay Shore, N. Y.	Diagnostic Roentgenology
129.	Cole, J. M.	Windsor, Ont.	Roentgenology
130.	Cole, Lewis Gregory	New York, N. Y.	Roentgenology
131.	Cole, Paul F.	Springfield, Mo.	Radiology
132.	Cole, William Gregory	New York, N. Y.	Roentgenology
133.	Coley, Stephen W.	Memphis, Tenn.	Roentgenology
134.	Collins, E. N.	Cleveland, O.	Diagnostic Roentgenology
135.	Collins, James N.	Indianapolis, Ind.	Radiology
136.	Collins, J. J.	Racine, Wis.	Radiology
137.	Cook, Orrin S.	Sacramento, Cal.	Roentgenology
138.	Cook, Philip H.	Worcester, Mass.	Radiology
139.	Cooley, R. M.	Jackson, Mich.	Roentgenology
140.	Coray, Q. B.	Salt Lake City, Utah	Roentgenology
141.	Corcoran, William J.	Scranton, Pa.	Roentgenology

142.	Costolow, William E.	Los Angeles, Cal.	Therapeutic Radiology
143.	Crain, C. F.	Corpus Christi, Tex.	Radiology
144.	Cramp, G. W.	Brooklyn, N. Y.	Roentgenology
145.	Crane, A. W.	Kalamazoo, Mich.	Roentgenology
146.	Crawford, Helen L.	Winona, Minn.	Roentgenology
147.	Crosby, Leonard G.	Denver, Colo.	Radiology
148.	Crossan, John W.	Los Angeles, Cal.	Diagnostic Roentgenology
149.	Crowder, E. R.	Evanston, Ill.	Roentgenology
150.	Cunningham, Lester W.	Mandarin, Fla.	Roentgenology
151.	Currin, Francis W.	Brooklyn, N. Y.	Roentgenology
152.	Cushway, B. C.	Chicago, Ill.	Radiology
153.	Dann, David S.	Kansas City, Mo.	Radiology
154.	Dannenberg, Max	Brooklyn, N. Y.	Roentgenology
155.	Danzer, Joseph T.	Oil City, Pa.	Radiology
156.	Dauksys, Joseph	Excelsior Springs, Mo.	Diagnostic Roentgenology
157.	Davidson, Sol C.	Rochester, N. Y.	Roentgenology
158.	Davis, Ernest L.	Springfield, Mass.	Roentgenology
159.	Davis, F. M.	San Antonio, Tex.	Diagnostic Roentgenology
160.	Davis, H. E.	Chicago, Ill.	Radiology
161.	Davis, Henry B.	Lancaster, Pa.	Radiology
162.	Davis, Kenneth S.	Los Angeles, Cal.	Roentgenology
163.	Davison, C. O.	Poughkeepsie, N. Y.	Radiology
164.	Davison, R. Winthrop	Trenton, N. J.	Roentgenology
165.	Debbie, Anthony G.	St. Albans, N. Y.	Diagnostic Roentgenology
166.	Decker, Fred H.	Peoria, Ill.	Radiology
167.	Dempster, J. H.	Detroit, Mich.	Diagnostic Roentgenology
168.	Derr, John S.	Frederick, Md.	Roentgenology
169.	Desjardins, Anatole	Wilkes-Barre, Pa.	Roentgenology
170.	Desjardins, A. U.	Rochester, Minn.	Radiology
171.	Deweese, E. R.	Kansas City, Mo.	Radiology
172.	Dick, Paul G.	Chicago, Ill.	Roentgenology
173.	Dickinson, J. C.	Tampa, Fla.	Roentgenology
174.	Dixon, George S.	New York, N. Y.	Diagnostic Roentgenology
175.	Donaldson, S. W.	Ann Arbor, Mich.	Roentgenology
176.	Doub, Howard P.	Detroit, Mich.	Radiology
177.	Doughty, William M.	Cincinnati, O.	Radiology
178.	Downing, Robert E.	Terre Haute, Ind.	Radiology
179.	Downs, Elwood E.	Woodbury, N. J.	Radiology
180.	Drane, Robert	Savannah, Ga.	Roentgenology
181.	Dresser, Richard	Boston, Mass.	Radiology
182.	Duckworth, Roy D.	White Plains, N. Y.	Roentgenology
183.	Duckworth, Willard D.	New Rochelle, N. Y.	Roentgenology
184.	Duffy, James J.	New York, N. Y.	Therapeutic Radiology
185.	Dunham, H. Kennon	Cincinnati, O.	Diagnostic Roentgenology
186.	Durrance, Fred Y.	Houston, Tex.	Roentgenology
187.	Eastland, William E.	Oklahoma City, Okla.	Therapeutic Radiology
188.	Eastmond, Charles	Brooklyn, N. Y.	Roentgenology
189.	Edeiken, Louis	Philadelphia, Pa.	Radiology
190.	Edwards, Harold G. F.	Shreveport, La.	Radiology
191.	Edwards, J. Bennett	Englewood, N. J.	Roentgenology
192.	Egbert, W. E.	Chester, Pa.	Diagnostic Roentgenology
193.	Ehrenpreis, Bernard	Brooklyn, N. Y.	Roentgenology
194.	Ehrlich, David E.	New York, N. Y.	Radiology
195.	Eldridge, Watson W., Jr.	Washington, D. C.	Roentgenology
196.	Eley, Clayton W.	Norfolk, Va.	Roentgenology
197.	Ellis, Ivan G.	Madison, Wis.	Roentgenology
198.	Elward, Joseph F.	Washington, D. C.	Roentgenology
199.	Eneboe, John B.	San Diego, Cal.	Radiology
200.	Enfield, Charles D.	Louisville, Ky.	Radiology
201.	Ericksen, Lester G.	South Bend, Ind.	Radiology
202.	Ernst, Edwin C.	St. Louis, Mo.	Radiology
203.	Erskine, Arthur W.	Cedar Rapids, Ia.	Radiology
204.	Evans, John	Baltimore, Md.	Roentgenology
205.	Evans, William A.	Detroit, Mich.	Radiology
206.	Eveleth, Fred S.	Concord, N. H.	Roentgenology
207.	Exner, Frederick B.	Seattle, Wash.	Radiology
208.	Farmer, Harry L.	Cleveland, O.	Radiology
209.	Farrell, John T., Jr.	Philadelphia, Pa.	Roentgenology
210.	Faust, J. J.	Tyler, Tex.	Radiology
211.	Feaster, O. O.	St. Petersburg, Fla.	Radiology
212.	Ferguson, James W.	Pittsburgh, Pa.	Radiology
213.	Feuerstein, Benjamin L.	Bay Shore, N. Y.	Therapeutic Radiology
214.	Fineman, Solomon	New York, N. Y.	Roentgenology
215.	Firor, Whitmer B.	Baltimore, Md.	Roentgenology

216.	Fisher, J. W.	Pittsburgh, Pa.	Radiology
217.	Fisher, L. F.	South Bend, Ind.	Roentgenology
218.	Flax, Nathan	Cincinnati, O.	Roentgenology
219.	Flinn, F.	Decatur, Ill.	Radiology
220.	Flynn, James M.	Rochester, N. Y.	Radiology
221.	Foley, Joseph M.	Peoria, Ill.	Roentgenology
222.	Ford, Frances A.	Detroit, Mich.	Radiology
223.	Fort, W. A.	Mare Island, Cal.	Roentgenology
224.	Fortier, Lucien A.	New Orleans, La.	Radiology
225.	Fray, Walter W.	Rochester, N. Y.	Radiology
226.	Freedman, Eugene	Cleveland, O.	Roentgenology
227.	Freedman, John	Detroit, Mich.	Roentgenology
228.	Freid, Jacob R.	New York, N. Y.	Radiology
229.	Frere, John M.	Chattanooga, Tenn.	Roentgenology
230.	Fricke, Robert E.	Rochester, Minn.	Therapeutic Radiology
231.	Friedland, Henry	New York, N. Y.	Diagnostic Roentgenology
232.	Friedman, Asa B.	Brooklyn, N. Y.	Radiology
233.	Friedman, Harry F.	Boston, Mass.	Radiology
234.	Friedman, Jacob	New York, N. Y.	Roentgenology
235.	Friedman, Lewis J.	New York, N. Y.	Diagnostic Roentgenology
236.	Friedman, Milton	Newark, N. J.	Therapeutic Radiology
237.	Fruchter, Joseph M.	Philadelphia, Pa.	Radiology
238.	Fugate, Isaac T.	Louisville, Ky.	Radiology
239.	Fulmer, Charles C.	San Francisco, Cal.	Roentgenology
240.	Fulton, Huston F.	Columbus, O.	Diagnostic Roentgenology
241.	Furey, Warren W.	Chicago, Ill.	Radiology
242.	Furst, Nathan J.	Newark, N. J.	Diagnostic Roentgenology
243.	Galanti, Charles P.	Chicago, Ill.	Roentgenology
244.	Garland, L. H.	San Francisco, Cal.	Radiology
245.	Gatelÿ, Tracy T.	New Orleans, La.	Radiology
246.	Gates, Russell	Minot, N. D.	Roentgenology
247.	Gelehrter, Joseph	Philadelphia, Pa.	Therapeutic Radiology
248.	Gemmel, J. H.	Philipsburg, Pa.	Roentgenology
249.	George, Arial W.	Boston, Mass.	Roentgenology
250.	Gerber, Isaac	Providence, R. I.	Radiology
251.	Gershon-Cohen, Jacob	Philadelphia, Pa.	Radiology
252.	Geyman, Milton J.	Santa Barbara, Cal.	Diagnostic Roentgenology
253.	Ghrist, David M.	Glendale, Cal.	Roentgenology
254.	Gianturco, Cesare	Urbana, Ill.	Roentgenology
255.	Giles, Roy G.	Temple, Tex.	Roentgenology
256.	Gillies, Carl L.	Cedar Rapids, Iowa	Radiology
257.	Gilmore, W. M.	Stratford, Ont.	Radiology
258.	Gingold, Joseph R.	Meadville, Pa.	Roentgenology
259.	Glover, M. H.	Wichita Falls, Tex.	Radiology
260.	Goin, Lowell S.	Los Angeles, Cal.	Roentgenology
261.	Golden, Ross	New York, N. Y.	Roentgenology
262.	Goldsmith, Maurice F.	Pittsburgh, Pa.	Roentgenology
263.	Goodrich, Murray E.	Toledo, O.	Radiology
264.	Goodwin, Perry B.	Peoria, Ill.	Radiology
265.	Gorfinkell, Julius	Pittsburgh, Pa.	Diagnostic Roentgenology
266.	Gorsline, Clarence S.	Battle Creek, Mich.	Roentgenology
267.	Grace, Joseph M.	Eloise, Mich.	Radiology
268.	Grady, Henry W.	Washington, D. C.	Radiology
269.	Graham, Ralph S.	Sacramento, Cal.	Radiology
270.	Granger, Amédée	New Orleans, La.	Radiology
271.	Gray, Horace D.	Memphis, Tenn.	Radiology
272.	Greenfield, Henry	Brooklyn, N. Y.	Radiology
273.	Grier, George W.	Pittsburgh, Pa.	Radiology
274.	Grimm, H. W.	Pittsburgh, Pa.	Therapeutic Radiology
275.	Groeschel, L. B.	New York, N. Y.	Radiology
276.	Groh, Jean A.	Cleveland, O.	Roentgenology
277.	Groover, Thomas A.	Washington, D. C.	Radiology
278.	Habbe, J. Edwin	Milwaukee, Wis.	Roentgenology
279.	Hackney, Urban P.	Dallas, Tex.	Radiology
280.	Hadley, Lee A.	Syracuse, N. Y.	Roentgenology
281.	Hall, E. Walter	Detroit, Mich.	Radiology
282.	Hall, Wendell C.	Philadelphia, Pa.	Radiology
283.	Hamilton, W. S.	San Antonio, Tex.	Diagnostic Roentgenology
284.	Hampton, A. O.	Boston, Mass.	Radiology
285.	Hankins, John L.	Johnson City, Tenn.	Roentgenology
286.	Hansen, Cyrus O.	Minneapolis, Minn.	Radiology
287.	Harding, D. B.	Lexington, Ky.	Radiology
288.	Hardy, Clyde C.	Omaha, Neb.	Diagnostic Roentgenology
289.	Hare, Hugh F.	Boston, Mass.	Radiology
290.	Harrington, B. D.	Tacoma, Wash.	Radiology

291.	Harris, Clarence P.	Houston, Tex.	Roentgenology
292.	Harris, John H.	Harrisburg, Pa.	Radiology
293.	Harris, Milo T.	Spokane, Wash.	Radiology
294.	Harris, T. T.	Omaha, Neb.	Radiology
295.	Harris, William	New York, N. Y.	Therapeutic Radiology
296.	Hartung, Adolph	Chicago, Ill.	Roentgenology
297.	Hasley, Clyde K.	Detroit, Mich.	Radiology
298.	Hauser, Harry	Cleveland, O.	Radiology
299.	Hawley, Sydney J.	Danville, Pa.	Roentgenology
300.	Haworth, Wallace	Portland, Ore.	Radiology
301.	Hay, Percy D., Jr.	Florence, S. C.	Radiology
302.	Heacock, Charles H.	Memphis, Tenn.	Roentgenology
303.	Healy, Thomas R.	Boston, Mass.	Roentgenology
304.	Heatley, John E.	Oklahoma City, Okla.	Diagnostic Roentgenology
305.	Heberding, John	Youngstown, O.	Radiology
306.	Hefke, Hans W.	Milwaukee, Wis.	Radiology
307.	Hendricks, Elliott M.	Fort Lauerdale, Fla.	Roentgenology
308.	Hendrickson, Anna R.	Canton, O.	Roentgenology
309.	Henle, Carye-Belle	Newark, N. J.	Roentgenology
310.	Henry, Lucas S.	Syracuse, N. Y.	Roentgenology
311.	Herpel, Frederick K.	West Palm Beach, Fla.	Roentgenology
312.	Herrman, W. G.	Asbury Park, N. J.	Radiology
313.	Hess, George H.	Uniontown, Pa.	Roentgenology
314.	Heylmun, Harry H.	Long Beach, Cal.	Diagnostic Roentgenology
315.	Hildreth, R. C.	Ann Arbor, Mich.	Radiology
316.	Hill, Harold A.	San Francisco, Cal.	Radiology
317.	Hill, Walter C.	Cleveland, O.	Roentgenology
318.	Hilt, Lawrence M.	Grand Rapids, Mich.	Roentgenology
319.	Hilton, James M.	Klamath Falls, Ore.	Roentgenology
320.	Hirsch, I. Seth	New York, N. Y.	Radiology
321.	Hodges, Fred J.	Ann Arbor, Mich.	Radiology
322.	Hodges, Fred M.	Richmond, Va.	Radiology
323.	Hodges, Paul C.	Chicago, Ill.	Radiology
324.	Hoffman, William J.	New York, N. Y.	Therapeutic Radiology
325.	Holly, Leland E.	Muskegon, Mich.	Roentgenology
326.	Holmes, George W.	Boston, Mass.	Radiology
327.	Holmes, Ralph W.	Chillicothe, O.	Roentgenology
328.	Holston, Joel D.	Massillon, O.	Roentgenology
329.	Hopkirk, C. C.	Santa Monica, Cal.	Roentgenology
330.	Horrigan, Arthur J.	Springfield, Mass.	Roentgenology
331.	Howard, Campbell	New York, N. Y.	Radiology
332.	Howard, William P.	Albany, N. Y.	Roentgenology
333.	Howes, William E.	Brooklyn, N. Y.	Radiology
334.	Hubeny, M. J.	Chicago, Ill.	Roentgenology
335.	Hufford, Clarence E.	Toledo, O.	Radiology
336.	Hunt, Howard B.	Omaha, Neb.	Radiology
337.	Hunt, Russell R.	Providence, R. I.	Roentgenology
338.	Hunter, James W., Jr.	Norfolk, Va.	Radiology
339.	Hutton, Frederick C.	Philadelphia, Pa.	Roentgenology
340.	Hynes, William P.	Washington, D. C.	Therapeutic Radiology
341.	Ikeda, Kano	St. Paul, Minn.	Roentgenology
342.	Illick, H. Earl	New York, N. Y.	Roentgenology
343.	Imboden, Harry M.	New York, N. Y.	Roentgenology
344.	Ingber, Irving S.	San Francisco, Cal.	Radiology
345.	Irwin, W. A.	Detroit, Mich.	Radiology
346.	Ivey, H. B.	Goldsboro, N. C.	Radiology
347.	Jaches, Leopold	New York, N. Y.	Radiology
348.	Jackson, Byron H.	Scranton, Pa.	Radiology
349.	Jackson, John B.	Kalamazoo, Mich.	Roentgenology
350.	Jacobs, Lewis G., Jr.	San Francisco, Cal.	Radiology
351.	Jacox, Harold W.	Pittsburgh, Pa.	Radiology
352.	Jarre, Hans A.	Detroit, Mich.	Radiology
353.	Jenkinson, David L.	Chicago, Ill.	Roentgenology
354.	Jenkinson, E. L.	Chicago, Ill.	Radiology
355.	Johannesson, Carl J.	Walla Walla, Wash.	Roentgenology
356.	Johnson, Brantley M.	Chicago, Ill.	Roentgenology
357.	Johnson, Clayton R.	Los Angeles, Cal.	Roentgenology
358.	Johnson, Ellsworth	Winchester, Va.	Roentgenology
359.	Johnson, Jesse B.	Galveston, Tex.	Radiology
360.	Johnson, Sydney E.	Louisville, Ky.	Diagnostic Roentgenology
361.	Johnson, Vincent C.	Ann Arbor, Mich.	Radiology
362.	Johnston, Zoe Allison	Pittsburgh, Pa.	Therapeutic Radiology
363.	Jones, Clifford F.	Cleveland, O.	Roentgenology
364.	Jones, Horace C.	Detroit, Mich.	Radiology

365.	Jones, William A.	Kingston, Ont.	Radiology
366.	Judson, Herbert A.	Los Angeles, Cal.	Roentgenology
367.	Judy, William S.	Greenville, S. C.	Radiology
368.	Kabakjian, Armen E.	Lancaster, Pa.	Radiology
369.	Kahn, Max	Baltimore, Md.	Roentgenology
370.	Kalbfleisch, William K.	Wheeling, W. Va.	Roentgenology
371.	Kann, U. S.	Binghamton, N. Y.	Radiology
372.	Kaplan, Ira I.	New York, N. Y.	Therapeutic Radiology
373.	Kaplan, Morris	New York, N. Y.	Diagnostic Roentgenology
374.	Kapo, Peter J.	Mahanoy City, Pa.	Radiology
375.	Kasabach, Haig H.	New York, N. Y.	Radiology
376.	Keichline, John M.	Huntingdon, Pa.	Radiology
377.	Keith, David Y.	Louisville, Ky.	Radiology
378.	Kelley, Jacob S.	Providence, R. I.	Roentgenology
379.	Kellogg, John O.	San Diego, Cal.	Radiology
380.	Kelly, James F.	Omaha, Neb.	Radiology
381.	Kenning, John C.	Detroit, Mich.	Radiology
382.	Kerby, James P.	Salt Lake City, Utah	Roentgenology
383.	Kerr, H. Dabney	Iowa City, Ia.	Radiology
384.	Kesmodel, Karl F.	Birmingham, Ala.	Radiology
385.	Kidder, Frank W.	Los Angeles, Cal.	Diagnostic Roentgenology
386.	King, J. Cash	Memphis, Tenn.	Radiology
387.	Kinney, Lyell C.	San Diego, Cal.	Radiology
388.	Kirkland, A. Stanley	St. John, N. B.	Roentgenology
389.	Kirklin, B. R.	Rochester, Minn.	Radiology
390.	Klapproth, Herman	Halstead, Kans.	Roentgenology
391.	Klein, William	New Brunswick, N. J.	Radiology
392.	Koiransky, Gennady H.	Long Island City, N. Y.	Diagnostic Roentgenology
393.	Kolvoord, Theodore	Battle Creek, Mich.	Diagnostic Roentgenology
394.	Kornblum, Karl	Philadelphia, Pa.	Radiology
395.	Kraft, Ernest	New York, N. Y.	Roentgenology
396.	Kuegle, F. H.	Janesville, Wis.	Roentgenology
397.	Kugler, Joseph C.	Jackson, Mich.	Roentgenology
398.	Kuhlman, Fred Y.	Springfield, Ill.	Roentgenology
399.	Lafferty, R. H.	Charlotte, N. C.	Radiology
400.	Landau, George M.	Chicago, Ill.	Roentgenology
401.	Landes, W. L. S.	York, Pa.	Roentgenology
402.	Langan, Paul C.	Akron, O.	Diagnostic Roentgenology
403.	Lange, Sidney	Cincinnati, O.	Radiology
*404.	Langer, Heinz	Pittsburgh, Pa.	Therapeutic Radiology
405.	Lanman, Everett L.	Battle Creek, Mich.	Roentgenology
406.	Lape, C. Pearley	Buffalo, N. Y.	Diagnostic Roentgenology
407.	Larkey, Charles J.	Bayonne, N. J.	Diagnostic Roentgenology
408.	Lattman, Isidore	Washington, D. C.	Radiology
409.	Law, F. M.	New York, N. Y.	Diagnostic Roentgenology
410.	Lawrence, W. S.	Memphis, Tenn.	Radiology
411.	Lawson, John D.	Sacramento, Cal.	Radiology
412.	Leddy, E. T.	Rochester, Minn.	Radiology
413.	Ledoux, Alfred C.	Evanston, Ill.	Radiology
414.	Leef, Edward	San Francisco, Cal.	Radiology
415.	LeFevre, Walter I.	Cleveland, O.	Roentgenology
416.	Lehman, J. S.	Philadelphia, Pa.	Radiology
417.	Leibert, Harry F.	Bethlehem, Pa.	Roentgenology
418.	Lenz, Maurice	New York, N. Y.	Therapeutic Radiology
419.	Leonard, Ralph D.	Boston, Mass.	Roentgenology
420.	Leucutia, T.	Detroit, Mich.	Radiology
421.	Levene, George	Boston, Mass.	Roentgenology
422.	Levi, Irwin P.	Anniston, Ala.	Roentgenology
423.	Levin, Alfred G.	Miami, Fla.	Radiology
424.	Le Vine, David	El Dorado, Ark.	Diagnostic Roentgenology
425.	Levine, Samuel	Philadelphia, Pa.	Radiology
426.	Levitin, Joseph	San Francisco, Cal.	Radiology
427.	Levyn, Lester	Buffalo, N. Y.	Diagnostic Roentgenology
428.	Lewis, Raymond W.	New York, N. Y.	Diagnostic Roentgenology
429.	Lhevine, Morris B.	Tulsa, Okla.	Roentgenology
430.	Liebman, Charles	Montreal, Que.	Roentgenology
431.	Liljedahl, Elmer N.	Los Angeles, Cal.	Roentgenology
432.	Lingeman, Leslie R.	Rochester, N. Y.	Roentgenology
433.	Lipschultz, Oscar	Minneapolis, Minn.	Roentgenology
434.	Litschgi, Joseph J.	Chicago, Ill.	Roentgenology
435.	Littig, L. V.	Madison, Wis.	Radiology
436.	Lochry, Ralph L.	Indianapolis, Ind.	Roentgenology
437.	Lockwood, Ira H.	Kansas City, Mo.	Radiology

* Deceased

438.	Loud, Norman W.	New Britain, Conn.	Diagnostic Roentgenology
439.	Lucas, Charles D.	Charlotte, N. C.	Therapeutic Radiology
440.	Lucinian, Joseph H.	Miami, Fla.	Roentgenology
441.	Lutz, Jeremiah F.	York, Pa.	Roentgenology
442.	MacColl, D. R.	Los Angeles, Cal.	Roentgenology
443.	MacComb, W. S.	New York, N. Y.	Therapeutic Radiology
444.	McCarthy, Humphrey L.	Boston, Mass.	Roentgenology
445.	McCarthy, Justin E.	Cincinnati, O.	Radiology
446.	McCaw, William W.	Washington, D. C.	Radiology
447.	McClanahan, Charles W.	West Los Angeles, Cal.	Radiology
448.	McClelland, Donald C.	Lafayette, Ind.	Radiology
449.	McClure, C. C.	Nashville, Tenn.	Radiology
450.	McCormick, Arthur F.	Du Bois, Pa.	Roentgenology
451.	McCormick, H. G.	Laurel, Miss.	Roentgenology
452.	McCormick, William M.	Du Bois, Pa.	Roentgenology
453.	McCullough, John F.	Pittsburgh, Pa.	Radiology
454.	McDeed, Winfield G.	Houston, Tex.	Roentgenology
455.	McDermott, Joseph L.	Kansas City, Mo.	Radiology
456.	McElfatrick, George C.	Wilmington, Del.	Roentgenology
457.	McEuen, Harry B.	Jacksonville, Fla.	Radiology
458.	McGaughey, H. D.	Joplin, Mo.	Radiology
459.	McGee, Harry H.	Savannah, Ga.	Roentgenology
460.	McGehee, William H.	Fresno, Cal.	Roentgenology
461.	McGlothlan, Arthur B.	St. Joseph, Mo.	Radiology
462.	McGuffin, W. Herbert	Calgary, Alberta	Radiology
463.	McHenry, Rupert K.	Houston, Tex.	Roentgenology
464.	McIntosh, Harriet C.	New York, N. Y.	Roentgenology
465.	McKinney, Joseph T.	Roanoke, Va.	Roentgenology
466.	McNabb, Atholl M.	Ottawa, Ont.	Roentgenology
467.	McNamee, Edgar P.	Cleveland, O.	Diagnostic Roentgenology
468.	McNutt, John R.	Duluth, Minn.	Radiology
469.	McPeak, Clarence N.	Fitchburg, Mass.	Roentgenology
470.	McPeak, Edgar M.	Washington, D. C.	Radiology
471.	Macmillan, A. S.	Boston, Mass.	Diagnostic Roentgenology
472.	Magruder, L. Freeland	Norfolk, Va.	Radiology
473.	Mahrer, Herbert A.	Cleveland, O.	Roentgenology
474.	Maier, Roe J.	Chicago, Ill.	Radiology
475.	Malcolmson, Patrick H.	Edmonton, Alberta	Radiology
476.	Malone, Leander A.	Terre Haute, Ind.	Radiology
477.	Mandeville, Frederick B.	Richmond, Va.	Roentgenology
*478.	Manges, Willis F.	Philadelphia, Pa.	Radiology
479.	Marchbanks, S. S.	Chattanooga, Tenn.	Radiology
480.	Marks, Joseph H.	Fall River, Mass.	Roentgenology
481.	Marquis, W. James	Newark, N. J.	Roentgenology
482.	Martin, Charles L.	Dallas, Tex.	Radiology
483.	Martin, James M.	Dallas, Tex.	Radiology
484.	Martin, W. C.	Louisville, Ky.	Roentgenology
485.	Mason, Claude H.	El Paso, Tex.	Diagnostic Roentgenology
486.	Masterson, John J.	Brooklyn, N. Y.	Roentgenology
487.	Matlack, James A.	Longmont, Colo.	Diagnostic Roentgenology
488.	Mattick, Walter L.	Buffalo, N. Y.	Radiology
489.	Maver, William W.	Jersey City, N. J.	Roentgenology
490.	Mawhinney, Harvey N.	Pittsburgh, Pa.	Diagnostic Roentgenology
491.	May, Ernst A.	East Orange, N. J.	Radiology
492.	May, Raymond V.	Cleveland, O.	Radiology
493.	May, Robert J.	Cleveland, O.	Radiology
494.	Mayfield, Claud	Long Beach, Cal.	Diagnostic Roentgenology
495.	Meadows, James A.	Birmingham, Ala.	Radiology
496.	Means, Hugh J.	Columbus, O.	Radiology
497.	Medelman, John P.	St. Paul, Minn.	Roentgenology
498.	Meland, Orville N.	Los Angeles, Cal.	Therapeutic Radiology
499.	Meltzer, Samuel L.	Portsmouth, O.	Diagnostic Roentgenology
500.	Mendelson, Emanuel	Brooklyn, N. Y.	Roentgenology
501.	Menees, Thomas O.	Grand Rapids, Mich.	Radiology
502.	Menville, Leon J.	New Orleans, La.	Radiology
503.	Merchant, Albert K.	Philadelphia, Pa.	Radiology
504.	Merrill, E. Forrest	New York, N. Y.	Roentgenology
505.	Merritt, E. A.	Washington, D. C.	Radiology
506.	Mesirow, Sidney D.	Chicago, Ill.	Roentgenology
507.	Meter, Edward G.	Reading, Pa.	Radiology
508.	Meyer, Keith T.	Evansville, Ind.	Roentgenology
509.	Meyer, William H.	New York, N. Y.	Radiology
510.	Miles, John M.	New Orleans, La.	Diagnostic Roentgenology

* Deceased

511.	Milkman, Louis A.	Scranton, Pa.	Roentgenology
512.	Miller, Harry A.	Baltimore, Md.	Radiology
513.	Millwee, Robert H.	Dallas, Tex.	Radiology
514.	Ming, Charles M.	Okmulgee, Okla.	Radiology
515.	Minor, Edward G.	Detroit, Mich.	Diagnostic Roentgenology
516.	Moffatt, F. J.	Medford, Ore.	Diagnostic Roentgenology
517.	Moloney, Albert M.	Boston, Mass.	Roentgenology
518.	Moore, Alexander B.	Washington, D. C.	Radiology
519.	Moore, Claude	Washington, D. C.	Radiology
520.	Moore, Daniel M.	Monroe, La.	Roentgenology
521.	Moore, John J.	San Francisco, Cal.	Radiology
522.	Moore, Paul D.	Muncie, Ind.	Radiology
523.	Moore, Sherwood	St. Louis, Mo.	Radiology
524.	Moore, Vernor M.	Grand Rapids, Mich.	Radiology
525.	Morrison, Murray C.	London, Ont.	Radiology
526.	Morrison, Sidney L.	Boston, Mass.	Roentgenology
527.	Morse, Russell W.	Minneapolis, Minn.	Roentgenology
528.	Morton, S. A.	Milwaukee, Wis.	Radiology
529.	Moxness, Bennie A.	Northampton, Mass.	Diagnostic Roentgenology
530.	Mueller, W. K.	St. Louis, Mo.	Diagnostic Roentgenology
531.	Mulligan, Peter B.	Ashland, Pa.	Roentgenology
532.	Murphy, G. W.	Asheville, N. C.	Roentgenology
533.	Murphy, John T.	Toledo, O.	Radiology
534.	Myers, Ralph E.	Oklahoma City, Okla.	Radiology
535.	Naslund, Ames W.	St. Paul, Minn.	Roentgenology
536.	Nathanson, Louis	Brooklyn, N. Y.	Radiology
537.	Nelson, Peter A.	Chicago, Ill.	Therapeutic Radiology
538.	Nessa, N. J.	Sioux Falls, S. D.	Roentgenology
539.	Newcomet, William S.	Philadelphia, Pa.	Radiology
540.	Newell, Robert R.	San Francisco, Cal.	Radiology
541.	Nichols, B. H.	Cleveland, O.	Radiology
542.	Nichols, Harold E.	Seattle, Wash.	Diagnostic Roentgenology
543.	Nordin, Gustaf T.	Minneapolis, Minn.	Radiology
544.	O'Bannon, R. P.	Fort Worth, Tex.	Radiology
545.	O'Boyle, Cyril P.	Philadelphia, Pa.	Diagnostic Roentgenology
546.	O'Brien, Frederick W.	Boston, Mass.	Radiology
547.	O'Connell, Andrew E.	Worcester, Mass.	Roentgenology
548.	O'Neill, John R.	San Francisco, Cal.	Roentgenology
549.	Oechsli, Waldo R.	Olive View, Cal.	Diagnostic Roentgenology
550.	Ogden, Ralph T.	Hartford, Conn.	Radiology
551.	Olin, Harry	Chicago, Ill.	Roentgenology
552.	Orndoff, B. H.	Chicago, Ill.	Radiology
553.	Orr, Clifford R.	Buffalo, N. Y.	Radiology
554.	Osmond, John D.	Cleveland, O.	Roentgenology
555.	Osmond, Leslie H.	Pittsburgh, Pa.	Radiology
556.	Ossip, Abraham	New York, N. Y.	Diagnostic Roentgenology
557.	Ostrum, Herman W.	Philadelphia, Pa.	Roentgenology
558.	Ourian, Adom K.	New York, N. Y.	Diagnostic Roentgenology
559.	Overgaard, Anders P.	Omaha, Neb.	Radiology
560.	Owen, Arthur K.	Topeka, Kans.	Roentgenology
561.	Owen, Colin C.	San Bernardino, Cal.	Roentgenology
*562.	Paine, Robert	Memphis, Tenn.	Radiology
563.	Pallen, Conde deS.	Rochelle Park, N. J.	Therapeutic Radiology
564.	Palmer, Dorwin L.	Portland, Ore.	Radiology
565.	Pancoast, Henry K.	Philadelphia, Pa.	Radiology
566.	Parker, Carl H.	Pasadena, Cal.	Roentgenology
567.	Parmelee, B. M.	Bridgeport, Conn.	Radiology
*568.	Parry, Leo D.	Easton, Pa.	Radiology
569.	Paul, Lester W.	Madison, Wis.	Diagnostic Roentgenology
570.	Pawling, Jesse R.	Watertown, N. Y.	Diagnostic Roentgenology
571.	Peden, Joseph C.	St. Louis, Mo.	Roentgenology
572.	Peirce, Carleton B.	Ann Arbor, Mich.	Radiology
573.	Pendergrass, E. P.	Philadelphia, Pa.	Radiology
574.	Pendergrass, Robert C.	Americus, Ga.	Roentgenology
575.	Percival, Milton F.	Philadelphia, Pa.	Radiology
576.	Perkins, Charles W.	Norwalk, Conn.	Roentgenology
577.	Perlberg, Harry J.	Jersey City, N. J.	Diagnostic Roentgenology
578.	Perley, Arthur E.	Waterloo, Ia.	Radiology
579.	Perry, Gentz	Evanston, Ill.	Radiology
580.	Peters, Chester M.	Canton, O.	Radiology
581.	Peterson, Charles H.	Roanoke, Va.	Roentgenology

* Deceased

582.	Peterson, George E.	Waukesha, Wis.	Radiology
583.	Peterson, V. L.	Charleston, W. Va.	Radiology
584.	Petrie, E. A.	St. Johns, N. B.	Roentgenology
585.	Pettit, Roswell T.	Ottawa, Ill.	Therapeutic Radiology
586.	Pfahler, G. E.	Philadelphia, Pa.	Radiology
587.	Philips, Herman B.	New York, N. Y.	Radiology
588.	Phillips, Clyde C.	Charlotte, N. C.	Radiology
589.	Pierce, Harold J.	Terre Haute, Ind.	Radiology
590.	Pierson, John W.	Baltimore, Md.	Radiology
591.	Pindell, Merl L.	Los Angeles, Cal.	Diagnostic Roentgenology
592.	Pines, John A.	Orlando, Fla.	Therapeutic Roentgenology
593.	Pirie, A. H.	Montreal, Que.	Radiology
594.	Pitts, Thomas A.	Columbia, S. C.	Roentgenology
*595.	Podlasky, Harry B.	Milwaukee, Wis.	Roentgenology
596.	Pohle, E. A.	Madison, Wis.	Therapeutic Radiology
597.	Pomeranz, Maurice M.	New York, N. Y.	Radiology
598.	Pomeranz, Raphael	Newark, N. J.	Roentgenology
599.	Pomeroy, Lawrence A.	Cleveland, O.	Radium Therapy
600.	Popoff, Constantine	Haverhill, Mass.	Diagnostic Roentgenology
601.	Popp, Walter C.	Rochester, Minn.	Therapeutic Radiology
602.	Porter, Horace W.	Jackson, Mich.	Radiology
603.	Portmann, U. V.	Cleveland, O.	Radiology
604.	Post, Joseph W.	Philadelphia, Pa.	Diagnostic Roentgenology
605.	Potter, Carlton F.	Syracuse, N. Y.	Roentgenology
606.	Potter, Hollis E.	Chicago, Ill.	Roentgenology
607.	Potter, Roy P.	Marshfield, Wis.	Roentgenology
608.	Pound, Robert E.	New York, N. Y.	Roentgenology
609.	Powell, E. V.	Temple, Texas	Radiology
610.	Powers, Martin T.	Utica, N. Y.	Diagnostic Roentgenology
611.	Powers, Richard T.	Springfield, Mass.	Radiology
612.	Powers, Robert A.	Palo Alto, Cal.	Radiology
613.	Price, R. J.	Dayton, O.	Radiology
614.	Prouty, J. V.	Terre Haute, Ind.	Radiology
615.	Putts, B. Swayne	Erie, Pa.	Roentgenology
616.	Quick, Douglas	New York, N. Y.	Therapeutic Radiology
617.	Quigley, D. T.	Omaha, Neb.	Radium Therapy
618.	Quimby, A. Judson	New York, N. Y.	Roentgenology
619.	Quiney, James J.	Easton, Pa.	Radiology
620.	Quinlan, Catherine M.	Santa Rosa, Cal.	Roentgenology
621.	Raap, Gerard	Miami, Fla.	Radiology
622.	Radding, Moses B.	Elizabeth, N. J.	Diagnostic Roentgenology
623.	Rathbone, Ralph R.	Washington, D. C.	Radiology
624.	Rauschenbach, Charles W.	Hammond, Ind.	Roentgenology
625.	Ravold, Henry J.	St. Joseph, Mo.	Radiology
626.	Ray, William B. G.	Pittsburgh, Pa.	Roentgenology
627.	Reaves, Hugh G.	Knoxville, Tenn.	Roentgenology
628.	Reed, Charles B.	Newburgh, N. Y.	Roentgenology
629.	Reeves, Robert J.	Durham, N. C.	Radiology
630.	Reiley, William E.	Clearfield, Pa.	Radiology
631.	Reineke, Harold G.	Cincinnati, O.	Roentgenology
632.	Reitter, George S.	East Orange, N. J.	Radiology
633.	Remer, John	New York, N. Y.	Therapeutic Roentgenology
634.	Rendich, Richard A.	Brooklyn, N. Y.	Roentgenology
635.	Reynolds, Lawrence	Detroit, Mich.	Radiology
636.	Rhinehart, Darmon A.	Little Rock, Ark.	Roentgenology
637.	Rhudy, Booker E.	Greensboro, N. C.	Roentgenology
638.	Rice, Frank M.	San Francisco, Cal.	Roentgenology
639.	Richards, Charles M.	San Jose, Cal.	Radiology
640.	Rigler, Leo G.	Minneapolis, Minn.	Radiology
641.	Ritvo, Max	Boston, Mass.	Radiology
642.	Ritzman, Allen Z.	Harrisburg, Pa.	Roentgenology
643.	Roberts, Douglas J.	Hartford, Conn.	Radiology
644.	Robin, Nathaniel H.	Hempstead, N. Y.	Roentgenology
645.	Robin, Percival A.	Hempstead, N. Y.	Roentgenology
646.	Robins, Samuel A.	Boston, Mass.	Roentgenology
647.	Robinson, G. Allen	New York, N. Y.	Therapeutic Radiology
*648.	Robinson, Ralph V.	Pittsburgh, Pa.	Roentgenology
649.	Robinson, Walter W.	Memphis, Tenn.	Roentgenology
650.	Rodenbaugh, Frederick H.	San Francisco, Cal.	Radiology
651.	Rodgers, Floyd D.	Columbia, S. C.	Radiology
652.	Rodick, J. C.	New Orleans, La.	Roentgenology
653.	Rodriguez, Juan	Fort Wayne, Ind.	Radiology

* Deceased

*654.	Roland, Marion M.	Oklahoma City, Okla.	Therapeutic Radiology
655.	Rork, Lee W.	Hastings, Neb.	Roentgenology
656.	Rose, Cassie B.	Chicago, Ill.	Radiology
657.	Rosenbaum, George	Philadelphia, Pa.	Diagnostic Roentgenology
658.	Rosh, Rieva	New York, N. Y.	Therapeutic Radiology
659.	Rousseau, J. P.	Winston-Salem, N. C.	Radiology
660.	Rowe, Edward W.	Lincoln, Neb.	Radiology
661.	Rowell, Edward E.	Stamford, Conn.	Roentgenology
662.	Rubenfeld, Sidney	New York, N. Y.	Therapeutic Radiology
663.	Rubert, Samuel R.	Chicago, Ill.	Roentgenology
664.	Rude, Joe C.	New York, N. Y.	Radiology
665.	Rudisill, Hillyer, Jr.	Charleston, S. C.	Radiology
666.	Ruggles, Howard E.	San Francisco, Cal.	Roentgenology
667.	Rulison, Foster C.	Syracuse, N. Y.	Roentgenology
668.	Rutledge, Clifford P.	Shreveport, La.	Radiology
669.	Rypins, Edwin L.	Bloomington, Ill.	Radiology
670.	Samuel, Ernest C.	New Orleans, La.	Roentgenology
671.	Sanderson, Stevens S.	Detroit, Mich.	Radiology
672.	Sante, L. R.	St. Louis, Mo.	Radiology
673.	Sargent, William H.	Oakland, Cal.	Radiology
674.	Schenck, Samuel George	Brooklyn, N. Y.	Radiology
675.	Schimmelpfennig, R. D.	Montclair, N. J.	Roentgenology
676.	Schmidt, Ernst A.	Denver, Colo.	Radiology
677.	Schmitz, Henry	Chicago, Ill.	Therapeutic Radiology
678.	Schnack, A. G.	Honolulu, Hawaii	Radiology
679.	Schnoebelen, Paul C.	St. Louis, Mo.	Roentgenology
680.	Schons, Edward	St. Paul, Minn.	Radiology
681.	Schumacher, F. L.	Pittsburgh, Pa.	Radiology
682.	Schwartz, Charles W.	New York, N. Y.	Roentgenology
683.	Schwartz, Irving	New York, N. Y.	Diagnostic Roentgenology
684.	Scott, Clifton R.	New Haven, Conn.	Roentgenology
685.	Scott, Wilhelmina S.	Lancaster, Pa.	Radiology
686.	Seeds, Asa E.	Spokane, Wash.	Radiology
687.	Shapiro, Abraham V.	Brooklyn, N. Y.	Diagnostic Roentgenology
688.	Shapiro, William M.	Toledo, O.	Radiology
689.	Sharpe, A. Maxwell	Chester, Pa.	Roentgenology
690.	Shaw, W. McL.	Jacksonville, Fla.	Roentgenology
691.	Shebesta, Emil M.	Detroit, Mich.	Radiology
692.	Sheldon, Francis B.	Stockton, Cal.	Radiology
693.	Sheridan, William M.	Spartanburg, S. C.	Radiology
*694.	Sherman, Herbert deG.	White Plains, N. Y.	Diagnostic Roentgenology
695.	Sherrick, Earl C.	Connellsville, Pa.	Diagnostic Roentgenology
696.	Shiflett, E. Lee	Louisville, Ky.	Roentgenology
697.	Shore, O. J.	Detroit, Mich.	Diagnostic Roentgenology
698.	Shoulders, H. S.	Nashville, Tenn.	Radiology
699.	Shulman, Simon	Far Rockaway, N. Y.	Roentgenology
700.	Sichler, Harper G.	Lafayette, Ind.	Radiology
701.	Sickels, Thomas N.	Watertown, N. Y.	Roentgenology
702.	Siefert, Alfred C.	Oakland, Cal.	Radiology
703.	Sigman, Frederick G	Salisbury, N. C.	Roentgenology
704.	Sims, George P.	Columbus, O.	Therapeutic Radiology
705.	Skinner, Edward H.	Kansas City, Mo.	Radiology
706.	Skomp, C. E.	Denver, Colo.	Diagnostic Roentgenology
707.	Smedal, M. I.	Boston, Mass.	Radiology
708.	Smith, Arthur B.	La Jolla, Cal.	Diagnostic Roentgenology
709.	Smith, B. B.	Buffalo, N. Y.	Diagnostic Roentgenology
710.	Smith, Jerome H.	San Angelo, Tex.	Radiology
711.	Smith, Lester A.	Indianapolis, Ind.	Radiology
712.	Smith, Richard L.	Grand Rapids, Mich.	Radiology
713.	Smith, R. Manges	Philadelphia, Pa.	Roentgenology
714.	Smith, Roscoe L.	Lincoln, Neb.	Radiology
715.	Smyth, Thomas L.	Allentown, Pa.	Roentgenology
716.	Snead, Lawrence O.	Richmond, Va.	Roentgenology
717.	Snow, Henry	Dayton, O.	Radiology
718.	Snow, William	New York, N. Y.	Roentgenology
719.	Snure, Henry	Los Angeles, Cal.	Roentgenology
720.	Soiland, Albert	Los Angeles, Cal.	Radiology
721.	Solis-Cohen, Leon	Philadelphia, Pa.	Radiology
722.	Sosman, M. C.	Boston, Mass.	Radiology
723.	Soule, Arthur B., Jr.	Burlington, Vt.	Roentgenology
724.	Spackman, Edgar W.	Philadelphia, Pa.	Radiology
725.	Spangler, Davis	Dallas, Tex.	Radiology
726.	Spencer, Hunter B.	Lynchburg, Va.	Roentgenology

* Deceased

727.	Spencer, Jack	Boston, Mass.	Radiology
728.	Spillman, Ramsay	New York, N. Y.	Diagnostic Roentgenology
729.	Spilman, Harold A.	Ottumwa, Ia.	Roentgenology
730.	Spinzig, Edgar W.	St. Louis, Mo.	Radiology
731.	Sproull, John	Haverhill, Mass.	Roentgenology
732.	Squire, Fay H.	Chicago, Ill.	Roentgenology
733.	Stafford, Owen R.	Los Angeles, Cal.	Therapeutic Roentgenology
734.	Stall, Arthur H.	Akron, O.	Radiology
735.	Stammel, Charles A.	Fort Benning, Ga.	Diagnostic Roentgenology
736.	Starks, Dorothy J.	Palo Alto, Cal.	Radiology
737.	Startz, Irving S.	Elmhurst, N. Y.	Roentgenology
738.	Stayton, Chester A.	Indianapolis, Ind.	Roentgenology
739.	Stecher, William R.	Darby, Pa.	Radiology
740.	Steel, David	Cleveland, O.	Roentgenology
741.	Steiner, Joseph M.	New York, N. Y.	Roentgenology
742.	Stephenson, F. B.	Denver, Colo.	Radiology
743.	Stevens, R. H.	Detroit, Mich.	Radiology
744.	Stewart, Harry M.	Johnstown, Pa.	Radiology
745.	Stewart, Wendell	East St. Louis, Ill.	Diagnostic Roentgenology
746.	Stewart, William H.	New York, N. Y.	Roentgenology
747.	Stone, Robert S.	San Francisco, Cal.	Roentgenology
748.	Strauss, Abraham	Cleveland, O.	Radium Therapy
749.	Stuart, Leon H.	Tulsa, Okla.	Roentgenology
750.	Sussman, Marcy L.	New York, N. Y.	Radiology
751.	Sutherland, Charles G.	Rochester, Minn.	Diagnostic Roentgenology
752.	Swenson, Paul C.	New York, N. Y.	Roentgenology
753.	Swope, Opie W.	Wichita, Kans.	Radiology
754.	Sycamore, Leslie K.	Hanover, N. H.	Radiology
755.	Tabb, John L., Jr.	Richmond, Va.	Roentgenology
756.	Taft, Robert B.	Charleston, S. C.	Radiology
757.	Talley, Daniel D., Jr.	Richmond, Va.	Roentgenology
758.	Tamarkin, Saul J.	Youngstown, O.	Radiology
759.	Taormina, Louis J.	Brooklyn, N. Y.	Diagnostic Roentgenology
760.	Taylor, Clifford C.	Indianapolis, Ind.	Radiology
761.	Taylor, Henry K.	New York, N. Y.	Diagnostic Roentgenology
762.	Taylor, Raymond G.	Los Angeles, Cal.	Radiology
763.	Taylor, Richard T.	Los Angeles, Cal.	Radiology
764.	Teitelbaum, Meyer D.	New Orleans, La.	Roentgenology
765.	Templeton, Frederic E.	Chicago, Ill.	Radiology
766.	Thomas, M. A.	Cleveland, O.	Radiology
767.	Thompson, Harold B.	Seattle, Wash.	Radiology
768.	Thuresson, Paul F.	Riverside, Cal.	Roentgenology
769.	Tice, Galen M.	Kansas City, Kans.	Radiology
770.	Tichy, L. S.	Chicago, Ill.	Roentgenology
771.	Titterington, Paul F.	St. Louis, Mo.	Roentgenology
772.	Treves, Norman	New York, N. Y.	Therapeutic Radiology
773.	Troje, Oscar R.	Fairfield, Ala.	Radiology
774.	Trostler, Isador S.	Chicago, Ill.	Radiology
775.	Troup, Ralph L.	Green Bay, Wis.	Radiology
776.	Troxell, William C.	Allentown, Pa.	Roentgenology
777.	Tuggle, Allen	New York, N. Y.	Radiology
778.	Tyler, Albert F.	Omaha, Neb.	Radiology
779.	Ude, Walter H.	Minneapolis, Minn.	Roentgenology
780.	Ulbrich, Henry L.	Detroit, Mich.	Roentgenology
781.	Ullmann, Henry J.	Santa Barbara, Cal.	Radiology
782.	Unfug, George A.	Pueblo, Colo.	Radiology
783.	Unger, Arthur S.	New York, N. Y.	Roentgenology
784.	Upson, Wilbur O.	Battle Creek, Mich.	Radiology
785.	Van Allen, Harvey W.	Springfield, Mass.	Radiology
786.	Van Buskirk, Edmund M.	Fort Wayne, Ind.	Roentgenology
787.	Van Nuys, Roscoe G.	Berkeley, Cal.	Radiology
788.	Van Winkle, LeRoy P.	Brooklyn, N. Y.	Diagnostic Roentgenology
789.	Vastine, Jacob H.	Philadelphia, Pa.	Radiology
790.	Velkoff, Metodi	Fort Wayne, Ind.	Roentgenology
791.	Virden, C. Edgar	Kansas City, Mo.	Radiology
792.	Vogt, Edward C.	Boston, Mass.	Roentgenology
793.	Voke, Edward L.	Akron, O.	Diagnostic Roentgenology
794.	Volderauer, John C.	Chicago, Ill.	Radiology
795.	Voltz, Albert L.	Richmond Hill, N. Y.	Roentgenology
796.	von Poswick, Gisela	Scranton, Pa.	Roentgenology
797.	Wachowski, T. J.	Chicago, Ill.	Roentgenology
798.	Walker, Howard M.	Fort Worth, Tex.	Radiology
799.	Wallace, K. K.	Norfolk, Va.	Radiology

800.	Walton, Henry J.	Baltimore, Md.	Radiology
801.	Warden, Marine R.	Albuquerque, N. M.	Roentgenology
802.	Warfield, Chester H.	Wichita, Kans.	Roentgenology
803.	Warren, Alva H.	Malden, Mass.	Diagnostic Roentgenology
804.	Wasch, Milton G.	Brooklyn, N. Y.	Radiology
805.	Wasson, W. W.	Denver, Colo.	Radiology
806.	Waters, Charles A.	Baltimore, Md.	Radiology
807.	Watkins, W. Warner	Phoenix, Ariz.	Radiology
808.	Weaver, Clarence E.	Detroit, Mich.	Roentgenology
*809.	Webb, James A. H.	Wichita, Kans.	Roentgenology
810.	Weber, Harry M.	Rochester, Minn.	Roentgenology
811.	Weeks, Paul R.	Denver, Colo.	Radiology
812.	Weiskotten, W. Otto	San Diego, Cal.	Roentgenology
813.	Weitzner, Imre	New York, N. Y.	Diagnostic Roentgenology
814.	Weitzner, Samuel F.	New York, N. Y.	Diagnostic Roentgenology
815.	Wentworth, A. J.	Mankato, Minn.	Radiology
816.	Wescott, William C.	Atlantic City, N. J.	Radiology
817.	West, James H.	Cleveland, O.	Radiology
818.	West, Theodore S.	Port Chester, N. Y.	Roentgenology
819.	Wheatley, Frank E.	Boston, Mass.	Radiology
820.	Wheatley, Louis F.	New Haven, Conn.	Roentgenology
821.	Whelan, Charles	Boston, Mass.	Radiology
822.	Whitehead, Lawther J.	Richmond, Va.	Roentgenology
823.	Whitlock, Simon B.	Norfolk, Va.	Roentgenology
824.	Widmann, B. P.	Philadelphia, Pa.	Radiology
825.	Wigby, Palmer E.	Dallas, Tex.	Radiology
826.	Wilcox, Clark A.	Wichita Falls, Tex.	Radiology
827.	Williams, Arthur J.	San Francisco, Cal.	Radiology
*828.	Williams, Francis H.	Boston, Mass.	Radiology
829.	Williams, Lester J.	Baton Rouge, La.	Radiology
830.	Williams, P. A.	Hempstead, N. Y.	Roentgenology
831.	Willy, Ralph G.	Chicago, Ill.	Roentgenology
832.	Wilson, Hugh M.	New Haven, Conn.	Roentgenology
833.	Wilson, James E.	Clarksburg, W. Va.	Diagnostic Roentgenology
834.	Wilson, John S.	Monticello, Ark.	Therapeutic Radiology
835.	Wilson, R. T.	Austin, Tex.	Roentgenology
836.	Wilson, Stanley A.	Lewiston, Me.	Roentgenology
837.	Winchell, A. Vaughn	Rochester, N. Y.	Therapeutic Radiology
838.	Wissler, J. E.	Washington, D. C.	Radiology
839.	Withers, Sanford M.	Denver, Colo.	Therapeutic Radiology
840.	Witwer, E. R.	Detroit, Mich.	Radiology
841.	Woolford, Joseph S.	Eureka, Cal.	Radiology
842.	Wright, Cecil S.	Indianapolis, Ind.	Radiology
843.	Wurster, Lloyd E.	Williamsport, Pa.	Roentgenology
844.	Young, Barton R.	Philadelphia, Pa.	Radiology
845.	Young, James L. R.	New York, N. Y.	Therapeutic Radiology
846.	Zink, Oscar C.	St. Louis, Mo.	Radiology
847.	Zulick, J. Donald	Philadelphia, Pa.	Roentgenology

* Deceased

In addition to the above list there are a number who have passed part of the examination and will appear again for examination in other branches.

There will be two examinations conducted by the Board during 1937, the first to be held in Atlantic City, June 4, 5, and 6, and the second in Chicago, Sept. 10, 11, and 12. Those who contemplate appearing before the Board at either of these meetings should have their applications in the Secretary's office at least three months in advance of the meeting.

The Board is preparing a new roster of all diplomates. The Secretary would appreciate information concerning anyone who has changed his location since receiving his certificate.

B. R. KIRKLIN, M.D.
Secretary-Treasurer,
The American Board of Radiology

BOOK REVIEWS

"EXPLORATION RADIOLOGIQUE DES COLONS ET DE L'APPENDICE AU MOYEN DES SOLUTIONS FLOCULANTES." By GEORGES MAINGOT, Electroradiologiste de l'Hôpital Laënnec, RAYMOND SARASIN, Ancien Interne des Hôpitaux de Geneve et de Zurich, and HENRI DUCLOS, Assistant de Radiologie a l'Hôpital Laënnec. Preface by ANTOINE BÉCLÈRE, Membre de l'Academie de Médecine. A volume of 230 pages, with 203 figures. Published by Masson et Cie, Paris, 1935. Price, 200 fr.

This volume extends the series dealing with the clinical radiology of the digestive tube begun so auspiciously under the authorship and direction of Duval, Roux, and Béclère, to include the large intestine and vermiform appendix. The work merits unstinted praise. Like its predecessors in the series, it might be looked upon as an atlas consisting of excellently prepared reproductions of roentgenographic specimens of the large intestine, terminal ileum, and appendix in normal and abnormal states. It is not, strictly speaking, an atlas, however, for the authors take occasion to describe in considerable detail the anatomic, physiologic, and pathologic basis for the roentgenographic appearance reproduced in the volume.

The book is divided into four parts. The first part deals with the general plan of the roentgenologic investigation of the colon, the technic, and with the anatomic and physiologic factors concerned with the roentgenologic examination of the mucosal surface of the intestine. The second part is given over to a discussion of the interpretation of the various roentgenographic appearances obtained, (*a*) when the bowel is moderately distended with opaque material, (*b*) after the opaque material has been evacuated from the intestine, (*c*) after the bowel has been re-distended with gas. This discussion becomes somewhat involved in spots and, while this reviewer is not in full accord with all the ideas expounded, he feels that a more complete understanding of many an obscure and confounding roentgenographic situation will be the reward of diligent study of this division of the volume. The third part deals in a graphic and instructive manner with the roentgenologic manifestations of abnormal intestinal states, organic and functional. Here again, especially when functional abnormalities are under discussion, one might find instances wherein the interpretation given by the authors might be questioned, but on the whole the material presented is well selected and arranged, and soundly interpreted on the basis of macroscopic pathologic anatomy. The fourth part is devoted to the vermiform appendix, to methods of demonstrating it roentgenologically, and to a consideration of its roentgenologic appearances in normal and diseased states. It seems to this reviewer that the authors have given this subject more intelligent consideration than has heretofore been given it in a single presentation. Nothing precisely new is offered to make the diagnosis of appendicitis an easier roentgenologic or clinical problem, but the authors face the situation squarely, eschew fantastic and farfetched interpretations, and demand that the roentgenologic diagnosis rest on data reflecting the pathologic anatomy of the disease.

Appended to the volume is a valuable bibliography and a complete index. Outstanding are the reproductions of roentgenograms, all of which must have been magnificent in the original, and the reproductions of them are beyond criticism, displaying an excellence of craftsmanship apparently not attainable in this country or at least not considered to be worthy of attainment. The volume deserves wide perusal and study.

"UROLOGICAL ROENTGENOLOGY: A MANUAL FOR STUDENTS AND PRACTITIONERS." By MILEY B. WESSON, M.D., Ex-president of American Urological Association, and HOWARD E. RUGGLES, M.D., Roentgenologist to University of California Hospital, St. Luke's Hospital, and Clinical Professor of Roentgenology, University of California Medical School. A volume of 269 pages, illustrated with 227 engravings. Published by Lea & Febiger, Philadelphia, 1936. Price, $5.00.

This is written as a manual for the student and the general practitioner and is a useful and timely addition to the literature on this subject. The volume commences with a brief but comprehensive review of the history of urography. The various technics are discussed from the standpoint of experience; fluoroscopic observation is condemned and many practical suggestions are offered with advice as to the number of exposures considered a safe maximum over a given period. With the new

contrast media now available, bilateral retrograde pyelography is almost universally routine. The common causes for error in interpretation are illustrated and explained and a very candid appraisal of the value of intravenous (excretory) urography is offered. The review of the normal and the various factors entering into the variations of the normal is a valuable feature. Renal ptosis is put upon a safe and sane foundation. Congenital anomalies of the kidney and ureter are well illustrated. Hydronephrosis is interestingly discussed as to etiology and treatment. Urogenital infections, including pyelitis, pyelonephritis and pyonephrosis, ureteral stricture, obstructive hydroureter, inflammatory infundibular stricture, carbuncle and cortical abscess are all succinctly and comprehensively handled. Renal tuberculosis and perinephritic abscess are the subject of useful suggestions in diagnostic methods. Pyelitis cystica, ureteritis cystica, and cystitis cystica are excellently illustrated.

The demonstration of renal calculi is discussed and useful hints are given for the differentiation of artefacts and extrarenal shadows. Fluoroscopy at the operating table and the use of the flexible film for post-operative shock is explained.

The recognition and differential features of renal tumor, solitary cyst, polycystic kidney, adrenal tumors, and Addison's disease constitute the subject of many excellent illustrations and diagrams thoroughly explained in the text.

Chapters on trauma and the neurologic lesions involving the urinary tract, with a discussion of malignant metastatic lesions involving bone, round off an excellent study of the whole subject of urologic roentgenology that is worthy of a place in the library of any one with any interest in this subject.

"ERGEBNISSE DER MEDIZINISCHEN STRAHLENFORSCHUNG (RÖNTGENDIAGNOSTIK, RÖNTGEN-, RADIUM- UND LICHTHERAPIE)." HERAUSGEGEBEN VON H. HOLFELDER, FRANKFURT A.-M.; H. HOLTHUSEN, Hamburg; O. JÜNGLING, Flensburg; H. MARTIUS, Göttingen; H. R. SCHINZ, Zürich. Volume 7, paper, 662 pages with 294 illustrations. Published by Georg Thieme, Leipzig, Germany, 1936. Price, M. 67.50; bound, M. 69.50.

This is the seventh volume of this well-known and favorably received radiologic system. To this number, as to the preceding ones, various specialists have each contributed a chapter on that radiologic subject with which they are most familiar, either in the field of diagnosis or of therapy. Kommerell discusses right-sided aorta; Teschendorf takes up Hand-Schüller-Christian's disease; then Zwerg and Laubmann review Albers-Schönberg's disease (marble bones); Erbsen writes on osteopoikilia; Uehlinger, on myositis ossificans progressiva; Teschendorf, on atelectasis of the lungs; Herrnheiser and Strnad close the diagnostic section of this book with a chapter on the perforation of the renal pelvis and ureter as seen in the pyelogram. In the therapeutic part of this book Bickenbach describes the radiotherapy of genital tuberculosis in the female; Dietel, the radium treatment of benign uterine hemorrhage; Zuppinger, the treatment of esophageal carcinoma; Schultz, the radiotherapy of lymphogranulomatosis; Weisswange, the radiotherapy of carcinoma of the breast. As usual, each chapter closes with a bibliography of the important works on the subject under discussion. Reference to the contents of the book is facilitated by an index of both authors and of subject matter. The make-up of this book, its illustrations and all are well up to Thieme's very high standard.

"RÖNTGENATLAS DER ERKRANKUNGEN DES HERZENS UND DER GEFÄSSE." Ein Leitfaden für Ärzte. By DR. W. BREDNOW, Privatdozent für innere Medizin und Röntgenologie; Oberarzt der medizinischen Universitäts-Klinik, Göttingen. A volume of 155 pages, with 87 illustrations. Published by Urban & Schwarzenberg, 1936. Price, 10.50 R.M.

Among the various roentgenologic methods of examining the heart and vessels, Brednow favors fluoroscopy and orthodiagraphy. These methods may be supplemented in certain special cases by kymography (which, the author states, is unsuitable for the needs of the general internist) or by plastic modelling of the heart. Roentgenologic examination is of greater value in cases of pulmonary tuberculosis. In cardiac disease the functional study of the heart is of the greatest importance. Yet here a roentgenologic study will give valuable anatomical or pathologic information about the size and shape of the heart. After an illustrated discussion of the normal heart, Brednow discusses in detail the roentgenologic findings in various pathologic cardiac and

vascular conditions. This book should be of great value to cardiologists and to internists especially, and to the roentgenologist, who will obtain much help in arriving at a diagnosis which may be of greatest assistance in the prognosis and treatment of a patient with a suspected cardiac or vascular lesion.

"THE 1936 YEAR BOOK OF RADIOLOGY." Diagnosis, edited by CHARLES A. WATERS, M.D., Associate in Roentgenology, Johns Hopkins University; Assistant Visiting Roentgenologist, Johns Hopkins Hospital; Associate Editor: WHITMER B. FIROR, M.D., Assistant in Roentgenology, Johns Hopkins University; Therapeutics, edited by IRA I. KAPLAN, B.Sc., M.D., Director, Division of Radiation Therapy Department, Bellevue Hospital, New York City; Associate Radiologist, Lenox Hill Hospital, New York City; Clinical Professor of Surgery, New York University Medical College. A volume of 604 pages, 616 illustrations. Published by The Year Book Publishers, Inc., 304 South Dearborn Street, Chicago, Illinois, 1936. Price, $4.50.

The Year Book of Radiology has already established itself as a necessary addition to the library of everyone who has an interest in roentgenology. It provides an up-to-date manual, profusely illustrated, including almost everything new in a rapidly widening field, for quick reference and comparison in puzzling cases.

The particular value of the book is that the roentgenographic findings are correlated with the clinical and other laboratory and experimental findings in the majority of the presentations. The important features of every paper have been comprehensively excerpted. The volume combines all the values of an interesting film file and a post-graduate course to one anxious to learn or even to the trained roentgenologist as a refresher course.

The section on radiotherapeutics likewise presents this subject both from the side of what can be accomplished and how it may be accomplished in a wide variety of clinically abnormal conditions.

The volume is valuable both to the roentgenologist and to the internist, the specialist and the surgeon, and is worthy of a place in the library of any of these as well as in that of the general practitioner.

"ROENTGENKIMOGRAFIA CONCENTRICA." By ALBERTO C. MORELLI, M.D. From the Institute of Radiology and the Faculty of Medicine of Montevideo, with an Introduction by CARLOS BUTLER. A volume of 70 pages, 32 plates. Montevideo, 1930.

Morelli describes a new type of kymograph differing from the usual devices in that the tracing of the heart in action is concentric. In this way a most accurate picture of the heart and aorta is obtained. Kymograms of the normal heart are presented and analyzed and then pathologic kymograms are discussed in thirty-two plates. The author discusses both the theoretical and practical advantages of his technic over the usual methods of kymography.

"ROENTGENOGRAPHIC TECHNIC." By DARMON ARTELLE RHINEHART, A.M., M.D., F.A.C.R., Professor of Roentgenology and Applied Anatomy, School of Medicine, University of Arkansas; Roentgenologist to St. Vincent's Infirmary, Baptist State Hospital, Missouri Pacific Hospital, and the Arkansas Children's Hospital, Little Rock, Ark. Second edition; 431 pages, 183 illustrations. Published by Lea & Febiger, Philadelphia, 1936. Price, $5.50 cloth.

This book is an excellent exposition of x-ray technic. The value of this work has already been well established and is one of the standard text-books on roentgenographic technic for x-ray technicians. It should be invaluable to medical students and especially to physicians who do roentgenographic work for themselves.

The author has revised the text thoroughly and has included the advances made in the field of roentgenographic technic. One new chapter has been added, some of the illustrations have been changed, 24 new figures have been provided, and the book itself has been increased in size.

While the general plan of work remains the same, a new method of charting the results of actual diagnostic exposures has been introduced, making it possible to develop a technic in the laboratory itself and with the equipment with which the technic is to be used. His technic may be used in any roentgen laboratory, irrespective of the apparatus that it may contain. The positioning and the special procedures to be applied for each part of the body are clearly presented.

For those not familiar with the First Edition,

the book contains 21 chapters, the contents as follows: I. Electricity and Electric Currents; II. Roentgen-ray Machines; III. Roentgen-ray Machines (continued); IV. Roentgen Rays or X-rays; V. Dark-room Equipment and Technic; VI. Introductory Experiments; VII. A Basic Roentgenographic Technic; VIII. Advanced Experiments; IX. Roentgenograms; X. Combinations of Exposed Factors; XI. Roentgenographic Technic with the Unit Type Roentgen-ray Machines; XII. Miscellaneous Instructions; XIII. The Upper Extremity; XIV. The Lower Extremity; XV. The Vertebral Column, Thorax, and Pelvis; XVI. The Head; XVII. The Teeth; XVIII. The Thoracic Viscera; XIX. The Gastro-intestinal Tract; XX. The Urinary Tract; XXI. Miscellaneous Examinations.

The author has kept in mind the needs of x-ray technicians, those of medical students in classes of roentgenology, and those of physicians doing roentgenographic work for themselves.

This text presents the subject in a thorough, modern, and practical way and should prove of inestimable value to those interested in roentgenographic technic.

"KURZ- UND ULTRAKURZWELLEN: BIOLOGIE UND THERAPIE." By Priv.-Doz. Dr. PAUL LIEBESNY, Leiter der Physikalisch-medizinischen Abteilung des Physiologischen Instituts im Allgemeinen Krankenhaus in Wien. Vol. 19 of "Sonderbände zur Strahlentherapie," 208 pages, 90 illustrations. Urban & Schwarzenberg, Berlin, 1935. Price, 8.50 R.M.

Liebesny, who is one of the pioneers in this new form of physical therapy, first discusses the historical and theoretical basis of short wave treatment, and substantiates much of it from his own experimental work. He feels that Hertzian waves have a specific biologic effect in addition to their thermal one, and contrasts the therapeutic effect of these waves with those obtained by diathermy. He evaluates his therapeutic results very conservatively and warns against over-enthusiasm for the method.

For the generation of Hertzian waves the author favors tube rather than spark gap apparatus. The effect of Hertzian waves on various biologic objects is discussed in some detail. Further, the effects of these waves on various inflammatory and malignant lesions and on pulmonary and nervous diseases are illustrated photographically and the author contrasts treatments of various kinds carried out at different wave lengths. In the final (fifth) chapter there is an explanation of the technical side of the therapeutic application of short and ultra-short wave radiations.

A bibliography of 17 pages includes all important works in this field. The book should be of interest to the physical therapist or internist rather than to the roentgenologists, who can, nevertheless, read the volume with interest and profit.

"EXPERIMENTAL STUDIES ON A TRANSMISSIBLE MYELOMATOSIS (RETICULOSIS) IN MICE." By OTTO KAALUND-JORGENSEN. Supplement 24 of "Acta Radiologica," paper, 142 pages, 25 illustrations. Published by Levin & Munksgaard, Copenhagen, 1936. Price, Swed. cr. 12.

This monograph is concerned chiefly with a presentation of the extensive experimental studies of the author on the transmission of myelomatosis (myeloid leukosis) in mice. A good review of the literature on the subject is presented in the first chapter. Subsequent pages deal with (1) the various methods of transmitting the disease to pre-irradiated and non-irradiated animals of the same and different strains, (2) heterotransfer, and (3) histologic and hematologic studies of the organs of animals that had succumbed to the disease. Much of the material is a confirmation of work recently reported by other investigators. The author stresses the differences between the filtrable tumors and leukoses of fowls and the transmissible tumors and leukoses of mammals, and especially the fact that in mice the disease cannot be transmitted by absolutely cell-free agents. Evidence is presented to show that the transmission of the myelomatosis in non-irradiated mice depends to a considerable degree on the genetic constitution of the animals, that the resistance determined by hereditary factors can be destroyed by general irradiation with roentgen rays. The report of successful heterotransfer of the myelomatosis from mice to pre-irradiated rats, re-transmission through two passages in irradiated rats, and then transmission back to non-irradiated mice is of considerable interest since heterotransfer of the disease has never been successfully accomplished before The lethal roent-

gen dose for the myelomatosis of mice was found to be between 3,100 and 3,700 r.

In the chapter on the histologic and hematologic studies of the disease, the author presents evidence to demonstrate that this condition fulfills the criteria of a myeloid, rather than lymphoid leukosis, namely, that it is a progressively fatal disease characterized by immature myeloid elements in the blood stream, hyperplasia of the bone marrow, and leukemic infiltrations in the various organs and tissues of the animal. A number of photomicrographs and one colored plate illustrate this.

The English translation is seemingly too literal in certain sections of the book, resulting in choppy style, poor sentence construction, and occasional obscurity of the exact meaning of the author. Nevertheless, this work should be of interest to pathologists, hematologists, roentgenologists, and investigators, in general, who are interested in the various problems relating to the leukemias.

"OPERATIVE AND INTERPRETIVE RADIODONTIA: A Textbook for Students and Practitioners of Dentistry." By WALTER S. THOMPSON, D.D.S., Associate Professor of Radiodontia, College of Dentistry, University of Southern California; Lieutenant, U. S. N. R., Special Service Instructor in Radiodontia; Director of Vocational Training in Operative Radiodontia, Los Angeles Junior College; Director of Operative and of Interpretive Radiodontia; Educational Courses offered by the Southern California State Dental Association; Consulting Radiodontist, Los Angeles County General Hospital, Cedars of Lebanon Hospital, etc. A volume of 355 illustrations, 374 pages. Published by Lea & Febiger, Philadelphia, 1936. Price, $7.00.

Thompson's "Operative and Interpretive Radiodontia" covers the field of technical radiodontia, in particular, in a most comprehensive manner. The book is divided into eleven chapters arranged in such a way that it would be valuable to the dental student, to the practitioner who is installing a new machine, as well as to the practitioner who has had considerable experience.

It contains almost all the methods of worth that have been published, as well as many new ideas of the author's, many of which will be found valuable in this field.

One chapter on "Interpretation of the Dental Roentgenogram" is made up largely of films contributed by a host of different men in the dental profession.

The book is well illustrated and the cuts are very good examples of various dental situations.

ABSTRACTS OF CURRENT LITERATURE

CONTENTS BY SUBJECT

THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

S. M. ATKINS, M.D., of Waterbury, Conn.
G. E. BURCH, M.D., of New Orleans, La.
JOSEPH DAUKSYS, M.D., of Excelsior Springs, Mo.
W. H. GILLENTINE, M.D., of New Orleans, La.
J. E. HABBE, M.D., of Milwaukee, Wisc.
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HANS A. JARRE, M.D., of Detroit, Mich.
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ERNST A. POHLE, M.D., Ph.D., of Madison, Wisc.
EMIL M. SHEBESTA, M.D., of Detroit, Mich.
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CONTENTS OF ABSTRACTS IN THIS ISSUE LISTED ALPHABETICALLY BY AUTHORS

BONE DISEASES (DIAGNOSIS)

Osteochondritis Dissecans of the Head of the Femur. E. Friedl. Röntgenpraxis, January, 1936, **8,** 16–21.

Aseptic necrosis of the head of the femur has been as common as aseptic necrosis in the knee joint, in the author's experience. In the Roentgen Institute of the University of Zürich, 21 cases have been seen in the last few years. In 12 cases it was bilateral; in four, on the right side; in five, on the left side. Eighteen cases were males and only three were females. Most of the cases were patients between 20 and 30 years of age. The osteochondritis is usually painless in its beginning and causes symptoms only when a rather large sequestrum has formed. It may be spontaneous on the basis of a constitutional weakness or secondary to trauma. If traumatic, it takes place during the first year after the injury. The necrotic portion of the bone is either absorbed and leaves a permanent defect, or new bone grows into it and replaces it. Arthritic changes are almost always found at a later date.

H. W. Hefke, M.D.

BONE GROWTH

The Clinical Significance of Skeletal Roentgen-ray Assessment in Children. T. Wingate Todd. Pennsylvania Med. Jour., August, 1936, **39,** 845–848.

The author has carried out measurements of bodily maturation in terms of skeletal maturity. The expression of maturity, in terms of union of epiphyses, for example, may disclose discrepancies between the chronological age and skeletal age. The construction of a skeletal maturity rating table similar to tables of height and weight depends upon long-term study and thus far a provisional table only has been published. In some children skeletal assessments indicate a relatively wide range of variation, a scatter which is evident in children who do not enjoy a high degree of constitutional fitness. "They evince a constitutional instability which, when present in more pronounced form, becomes a retardation in maturity below that of the healthy majority."

The clinical significance of skeletal roentgen-ray assessment in children may also be expressed in a measurement of mineral reserve and its relationship to the pituitary-parathyroid-vitamin D complex as well as in the rate of growth of individual bones.

W. A. Sodeman, M.D.

THE BRAIN

Discussion on the Value of Radiology in Neurosurgery. E. W. Twining, Hugh Cairns, M. H. Jupe, Geoffrey Jefferson, D. W C. Northfield, and J. P. Martin. Proc. Royal Soc. Med., July, 1936, **29,** 1155–1173.

The authors briefly discuss the problems and radiologic criteria employed in the diagnosis of neoplastic and non-neoplastic tumors of the brain and its covering. There is little space devoted to the treatment of those conditions by irradiation.

G. E. Burch, M.D.

FRACTURES

Volkmann's Ischemic Contracture Associated with Supracondylar Fracture of Humerus. Henry W. Meyerding. Jour. Am. Med. Assn., April 4, 1936, **106,** 1139–1144.

This flexion deformity of the wrist and fingers resulting from contraction and fibrosis of the flexion muscles of the forearm, affecting children and occurring as a complication of fractures of the lower end of the humerus, results in permanent, partial, or total disability when once it is established, despite the most expert surgical and physical treatment.

The extensiveness of the primary injury and the time interval between trauma and consultation are of the utmost importance, irrespective of the treatment. Volkmann's ischemic contracture can occur even when no treatment has been given. In a matter of hours the damage to the muscle fibers has been done. Conservative methods of treatment, such as the stretching method advised by Sir Robert Jones, give the best results. Surgery is resorted to only when conscientious and prolonged treatment has failed to correct the deformity. Physical therapy is the greatest aid in recovery of a useful extremity.

Charles G. Sutherland, M.B. (Tor.).

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

A Summary of Regional Ileitis with Report of a Case of Colonic Involvement and Suggestion of a New Term. A. J. Rosenblate, A. A. Goldsmith, and A. A. Strauss. Jour. Am. Med. Assn., May 23, 1936, **106,** 1797–1800.

Crohn *et al.*, in 1932, designated a number of granulomatous conditions of the intestine possessing common symptomatic and pathologic features variously described for the past three decades. A year later Harris and his collaborators, because of the cicatrizing inflammatory process and the probable involvement of other portions of the intestinal tract, suggested the term "cicatrizing enteritis."

No definite etiologic factor or factors have been isolated. The usual site of the disorder is the terminal ileum, though other portions of the intestine may be involved. The pathologic picture is that of inflammation of the ileac mucosa with subsequent ulceration. The intestinal coats are edematous and thickened. The mesentery is thickened and the glands are hyperplastic. Eventually, owing to the fibrostenotic process, narrowing of the lumen results. There is a marked tendency toward perforation and the formation of a localized mass in the right lower quadrant and of a fistula into the adjoining intestine.

Roentgenologic investigation is the most essential means of establishing the diagnosis. Abnormalities, as revealed by the ingested meal as well as the opaque enema, include: (*a*) Filling defects in the ileum just proximal to the cecum; (*b*) abnormality in contour of the terminal loop of the ileum; (*c*) dilatation of ileac loops (in the stenotic phase) just proximal to the lesion.

Kantor's "string sign," while not pathognomonic, is strikingly suggestive and characteristic. This has been observed in sarcoma and in syphilis of the terminal ileum.

The authors report a case and suggest the term "ileocolitis ulcerosa chronica" in cases in which the pathologic condition extends to the colon.

CHARLES G. SUTHERLAND, M.B. (Tor.).

Chronic Paralytic Duodenal Stasis. J. Ducuing and P. Fabre. Arch. d. Mal. de l'App. Digestif, June, 1936, **26,** 625–651.

The symptom-complex of stasis in the second and third portions of the duodenum with no organic obstruction present at operation is reported in a series of five cases. The gall bladders were also found to be normal though no shadows had been obtained following administration of the dye. Clinically there were present dyspepsia and irregular abdominal distress, accompanied by a marked emaciation and an earthy complexion.

Fluoroscopically there was seen marked dilatation of the second and third portions of the duodenum with persistent stasis in this segment. Violent and ineffective peristaltic movements as well as waves of reverse peristalsis with reflux of duodenal contents into the stomach were also noted.

Medical treatment, including the use of antispasmodics, resulted in no improvement. The treatment of choice is surgery, a duodeno-jejunostomy.

JOSEPH DAUKSYS, M.D.

Intestinal Obstruction Due to a Hole in the Mesentery of the Ascending Colon: Passage of Descending Colon and Sigmoid through Dense Ring in Mesentery of Ascending Colon. Thomas S. Cullen. Jour. Am. Med. Assn., March 14, 1936, **106,** 895–898.

A review of the literature revealed that abnormal openings in the mesentery are rare: they are usually of congenital origin. Injury has not been demonstrated as an etiologic factor in many instances. The openings are most frequently located in the mesentery to the ileum within 2 to 3 inches of its junction with the cecum. When intestinal obstruction results, massive resections are likely to be required. Only two cases are recorded in which obstruction of the large bowel occurred. In the author's case there was a ring-like opening in the mesentery of the ascending colon. The ring was about two centimeters in diameter and its walls were very firm. Redundant descending colon and sigmoid passing over to the right, through the ring-shaped opening, could not get back and became obstructed. Extreme tension of the mesentery of the distended bowel by pressure had produced blockage of the vessels of the lower portion of the ileum and caused death of more than five feet of the distal portion of the small bowel. Emergency operation was followed by recovery and nine months later the patient was in excellent condition.

CHARLES G. SUTHERLAND, M.B. (Tor.).

A Combined Form of Ileitis and Colitis. Burrill B. Crohn and Bernard D. Rosenak. Jour. Am. Med. Assn., Jan. 4, 1936, **106,** 1–7.

In nine of 60 cases of ileitis surgically treated and confirmed, six were accompanied by a simultaneous inflammatory and ulcerative colitis. The condition has identifying characteristics, clinical symptoms, and a course of its own. Colp, in 1934, published a report of the first case surgically proved, with full details of the pathology.

The authors regard the process as an involvement of both small and large intestines by a similar non-specific inflammatory process, the ileum reacting to the infecting agent as a granuloma, the large intestine as an ulcerative and hyperplastic colitis. The relationship is usually not sequential but synchronous. Occasionally, however, it appears as a primary ileitis and spreads to the colon.

The diagnosis rests on careful and accurate roentgenographic studies, using both the ingested barium meal and the barium enema.

CHARLES G. SUTHERLAND, M.B. (Tor.).

GENITO-URINARY TRACT (DIAGNOSIS)

The Embryologic and Clinical Aspect of Double Ureter. Allan B. Hawthorne. Jour. Am. Med. Assn., Jan. 18, 1936, **106,** 189–193.

This anomaly is one of the most common of all urinary malformations and the etiologic factor in many renal lesions. There are two types: *complete* (two pelves on the same side, one superior to the other, draining by separate ureters and opening by separate orifices on to the floor of the bladder) and *incomplete* (two pelves and two upper ureters joining to enter the bladder by one common ureter). Both these forms of duplication may be unilateral or bilateral. Minor degrees of bifurcation are commonly referred to as bifid pelves.

The embryologic factors concerned are discussed in detail.

In 52 of a series of 63 double ureters some pathologic lesion was present. The two predominating lesions were obstruction, with resultant hydro-ureter and hydronephrosis, and infection. Evidence of hydronephrosis was present in 48, and 50 of the 52 showed evidences of infection. In the majority of cases the lesion was one of infected hydronephrosis. Of the 52 cases, only 13 were treated by operative measures, and these all belonged to the group of incomplete bifurcations.

The treatment as far as the double ureter is concerned is really the treatment of the accompanying surgical lesion, for the ectopic supernumerary ureter, complete or partial ureterectomy with nephrectomy or heminephrectomy as the condition indicates.

CHARLES G. SUTHERLAND, M.B. (Tor.).

Surgical Treatment of Anomalies of Upper Urinary Tract in Children. Meredith F. Campbell. Jour. Am. Med. Assn., Jan. 18, 1936, **106,** 193–196.

An anomalous organ is more prone to disease than a normal one. The incidence of anomalous development is highest in the urinary tract. If congenital narrowing of the urethral meatus is disregarded, anomalies occur more often in the upper than in the lower urinary tract. If anomalies exist in the lower urinary tract or in the genital system, the chances are better than one in three that the upper urinary tract is anomalous. The suggestive diagnostic corollary of this observation is at once apparent.

In the main, anomalies of the upper urinary tract are important as (1) the renal reserve is diminished, (2) the kidney is misplaced or malformed, (3) there is urinary obstruction, or (4) there is abnormal discharge of urine (ectopic ureteral orifice). Chief interest focuses on the obstructive uropathy for here it is that one encounters (1) congenital hydronephrosis, which comprises the majority of all hydronephroses in children, and, even more important if incidence and morbidity are the criteria, (2) chronic pyuria.

Delayed diagnosis of the commoner anomalies of the upper urinary tract too often renders nephrectomy necessary.

The author has tabulated the anomalies in his series and discusses the surgical treatment of the individual types of lesion.

CHARLES G. SUTHERLAND, M.B. (Tor.).

Rôle of Anomalies of Kidney and Ureter in Causation of Surgical Conditions. Robert Gutierrez. Jour. Am. Med. Assn., Jan. 18, 1936, **106,** 183–189.

With the advent of cystoscopy and catheterization of the ureters and the discovery of pyelography came the recognition of innumerable malformations and pathologic conditions of the kidney that were never before suspected. It can safely be said that fully 40 per cent of all pathologic conditions of the kidney and ureter are due to congenital anomalies. These predispose to poor function, and to urinary stasis, with resultant retention and possible infection. Such a condition is potentially a clinico-pathologic entity and liable to become a surgical condition. The development of pathologic lesions in congenitally abnormal kidneys may be relatively silent in some instances. Careful cystoscopic and urographic study should be made in every case in which the slightest urinary symptoms become manifest in patients suffering from various gastro-intestinal symptoms suggesting a lesion of some abdominal or pelvic organ or a functional disturbance of the gastro-intestinal tract. The author reviews the development of the urogenital system and the anomalies resulting from various aberrancies. Their symptomatology is discussed in detail. Diagnosis involves the study of the patient's history, the clinical symptoms, and a thorough physical examination. The urologic examination includes cystoscopy, catheterization of the ureters, renal functional tests, roentgenography, pyelography, retrograde (ascending) or excretory (descending), and sometimes cystoscopy and pyeloscopy. The advantages and limitations of intravenous methods are considered. In three comprehensive tables the various types of anomaly to be sought for are tabulated.

CHARLES G. SUTHERLAND, M.B. (Tor.).

Ureteropelvic (Renal) Obstruction in the Young. Earle R. Hall. Canadian Med. Assn. Jour., August, 1936, **35,** 140–142.

Hall points out that renal obstruction at the ureteropelvic junction occurs in childhood more often than is fully recognized, but is usually not discovered until adult life, after considerable damage has occurred. Complications, such as stone and infection, prompt recognition at a time when conservative treatment is often impossible.

The importance of early recognition is obvious. A careful history may be helpful in bringing out recurrent periods of pain, and physical examination may disclose a palpable kidney. However, pyelograms are most helpful, especially the functional pyelogram obtained by the intravenous route, which not only shows the obstruction but demonstrates the ability of the kidney pelvis to empty as well.

W. A. SODEMAN, M.D.

HEART AND VASCULAR SYSTEM

Calcifications in the Cardiac Valve Demonstrable Roentgenologically. B. Kommerell. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1936, **53,** 34–44.

Ten cases are reported in which calcifications of the cardiac valves were diagnosed roentgenologically during life. One of these cases could be confirmed at autopsy. The value of recognition of such endocardial calcifications by fluoroscopy is emphasized. To permit of radiographic demonstration, one requires the shortest possible exposures with sufficiently powerful equipment. Calcifications were observed in the aortic valves, the mitral, and the annulus fibrosus of the mitral. The possibilities of their localization and differentiation are discussed.

H. A. JARRE, M.D.

The Symptomatology of an Aneurysm of the Abdominal Aorta. Burkhard Kommerell. Röntgenpraxis, January, 1936, **8,** 25–28.

A case of a dissecting aneurysm of the abdominal aorta is described (non-syphilitic). It was found below the left diaphragm and had led to a roentgenologically demonstrable impression of the cardia and its displacement close to the anterior abdominal wall. Clinically, there were dysphagia, vomiting, and abdominal pain, but no abnormal abdominal pulsation. An autopsy confirmed the diagnosis.

H. W. HEFKE, M.D.

Extrapericardial Fat Bodies. Friedrich G. Kautz and Max Pinner. Am. Jour. Roentgenol. and Rad. Ther., January, 1936, **35,** 40–43.

These are shadows most commonly seen between the cardiac apex and the left dome of the diaphragm, occasionally between the inferior right border of the heart and the right dome. They are either continuous between these structures or may be separated from the diaphragm by a narrow zone of lesser density. They are triangular, though showing a slight lateral convexity, and may be the same density as the heart or less dense.

It is important to remember that this density is not abnormal. The literature is reviewed and a case is presented revealing the density of both sides of the heart—proven by autopsy.

S. M. Atkins, M.D.

The Roentgen Diagnosis of Aneurysm of the Aortic Sinus Valsalva. H. U. Albrecht. Fortschr. a. d. Geb. d. Röntgenstrahlen, March, 1936, **53,** 218–222.

This paper contains a report of three cases of such aneurysm. One was confirmed by autopsy: in two, the aneurysm involved the sinus of Valsalva exclusively. In the third case, however, there was pronounced aneurysmatic dilatation of aorta and innominate artery besides a fist-sized aneurysm of the sinus Valsalva. In this latter case there was also extensive calcification of the walls of the aneurysm and erosion of the sternum posteriorly.

For differential diagnosis one will have to consider mediastinal tumor, cyst, and inflammatory pericardial diverticula. Syphilis usually is confirmed serologically.

H. A. Jarre, M.D.

Four Years of Kymography of the Cardiovascular System. Delherm and Fischgold. Fortschr. a. d. Geb. d. Röntgenstrahlen, March, 1936, **53,** 223–232.

This paper emphasizes the value of kymography as developed by Stumpf for the investigation of the cardiovascular system. From their studies the authors have developed the conceptions of "diastolic tonus" and "post-systolic residue," and from the application of these conceptions they draw conclusions as to the explanation of extra-systoles and alternating pulse.

The paper will be of interest to those few American radiologists who employ the method of kymography in any of its forms.

H. A. Jarre, MD.

The Roentgen Diagnosis of Aneurysms of the Internal Carotid Artery. Andreas Gáal. Röntgenpraxis, June, 1936, **8,** 366–372.

Roentgen examination is only occasionally of help in the diagnosis of aneurysms of the internal carotid artery. The roentgen signs are erosions of the neighboring bones.

Two interesting cases are described: one showed slight enlargement of the sella turcica, a double contour of its base, slight osteoporosis of the bone forming the left optic canal, and a definite enlargement of all foramina in the base of the left skull, especially the hiatus of the carotic canal. The clinical symptoms and the effect of ligation proved the correctness of the diagnosis. The second case showed similar roentgenologic changes, best seen on the films of the base of the skull.

It seems possible to employ the roentgen examination in similar cases as a helpful diagnostic means.

H. W. Hefke, M.D.

Reversible Cardiac Enlargement. John E. Walker. Jour. Am. Med. Assn., May 23, 1936, **106,** 1795, 1796.

Cardiac enlargement is usually associated with valvular defects or with hypertension. Once established in connection with these diseases, the enlargement is, in general, irreversible and constitutes a discouraging feature in the treatment of heart disease.

Roentgenograms showing a striking return to normal size of enlarged hearts in arteriovenous aneurysm, beriberi, and myxedema, demonstrate that these three diseases are readily amenable to specific treatment and also that an enlarged heart is not always a permanent irreversible condition.

Charles G. Sutherland, M.B. (Tor.).

The Roentgen Diagnosis of Non-calcified Thrombi of the Heart. Emil Füssl. Röntgenpraxis, June, 1936, **8,** 377–380.

An intracardial thrombus can be seen on roentgen examination only if it is calcified or if it changes the contour of the heart shadow. The author has found only one roentgenologically suspected case proved by autopsy. In his own case the contour of the heart and mediastinum was changed so markedly that a mediastinal tumor was suspected. In both hilum regions there was a round, well-circumscribed tumor the size of a child's fist; pulsation could not be made out. At autopsy this tumor was seen to be a greatly enlarged left auricle filled with thrombotic material. An enlargement of the left auricle without corresponding increase in size of the other parts of the heart should make one think of thrombosis of the left auricle.

H. W. Hefke, M.D.

Direct Venography in Obstructive Lesions of the Veins. Nelson W. Barker and John D. Camp. Am. Jour. Roentgenol. and Rad. Ther., April, 1936, **35,** 485–489.

Diodrast in 10 c.c. or 20 c.c. quantities has been injected into the veins of parts showing venous obstruction. For upper extremity study 10 c.c. has been found sufficient, while for the lower extremity 20 c.c. is recommended. The injection is made rapidly at the rate of approximately 1 c.c. per second. There are occasional mild reactions (light-headedness or nausea and vomiting), but no severe ones and no thromboses. Films must be made rapidly (preferably on the Bucky) immediately after injection, for the veins empty rapidly,

even in pathologic cases, so that good visualization of the veins is obtained in only one film.

In normal cases the vein injected is usually visualized well up into the trunk, the density of the venogram diminishing centrally, with little retrograde visualization of the tributaries. In obstructive cases there is visualization of many diverging and tortuous collateral channels, the main venous trunks being visualized for only a short distance beyond the point of injection.

The procedure is safe and simple. The only contraindications are recent (within two weeks) acute thrombophlebitis and idiosyncrasy to iodides.

J. E. Habbe, M.D.

HEMORRHAGE

Rendu-Osler-Weber Disease. Hyman J. Goldstein. Riforma Med., Feb. 22, 1936, **52,** 256, 257. (Reprinted by permission from British Med. Jour., May 16, 1936, p. 79 of Epitome of Current Medical Literature.)

The author gives this name to the condition otherwise known as heredo-familial angiomatosis with Goldstein's recurrent hemorrhages, which was described by Rendu in 1896, Osler in 1901, 1907, and 1911, Parkes Weber in 1907 and 1924, and Goldstein in 1921. The three essential features are heredity, hemorrhages, and telangiectases on the skin and mucous membranes. The patients do not bleed excessively after teeth extraction or accidental wounds. The condition has nothing in common with hemophilia, essential thrombocytopenia, pernicious anemia, splenic anemia, or Glanzmann's familial thrombasthenia. In some advanced cases the liver and spleen may be enlarged. There are about 120 affected families on record, comprising about 850 individuals.

Treatment consists in cauterization of the bleeding telangiectases or the application of x-rays or radium to the telangiectases of the spleen or liver. Calcium is administered by mouth or intravenously, with or without thrombotic extracts, to check the hemorrhage. Snake venom is small doses has been used, and preparations rich in vitamins are recommended.

THE HIP JOINT

Roentgen Technic for the Internal Fixation of Fractures of the Femoral Neck. Charles H. Peterson. Am. Jour. Roentgenol. and Rad. Ther., February, 1936, **35,** 226–229.

By the use of the roentgen films of the normal hip the length of the neck and its anterior angulation is determined. This is done by taking a number of films at varying oblique angles of the neck, with the film always at right-angles to the ray. The femur is rotated until the entire neck is superimposed on the head, thus causing the neck to be flat. With a measuring rod attached to the center of the greater trochanter, a film taken of this region can thus allow exact measurement of the length of the neck. With the above accurate knowledge, the correct size of nail can be chosen. The nail is driven through the greater trochanter, fractured neck, and into the center of the head in stages, each being checked by stereoscopic film examination.

This method permits operation through only a small skin incision, the patient moving about on crutches on the third or fourth day. The nail is removed when the fracture line has healed. The results appear to be very good as non-union has not occurred in any one case up to this writing.

S. M. Atkins, M.D.

HODGKIN'S DISEASE

Hodgkin's Disease of Bone Marrow and Liver without Apparent Involvement of Lymph Nodes. Harry Herscher. Am. Jour. Roentgenol. and Rad. Ther., January, 1936, **35,** 73–77.

A case of Hodgkin's disease of bone without apparent involvement of lymph nodes is presented, only one other case of this type having been recorded in the literature. The case was characterized by an acute clinical course, only three months in duration from the onset of symptoms to the time of death. The roentgenograms of the involved bones suggested a metastatic malignancy; in the skull the appearance resembled multiple myeloma.

The frequency of bone marrow involvement in Hodgkin's disease is much more common than is ordinarily suspected, and, as some investigators believe, may be universal in advanced cases.

S. M. Atkins, M.D.

Hodgkin's Disease of the Lung. Ernest H. Falconer and Maurice E. Leonard. Am. Jour. Med. Sci., June. 1936, **191,** 780–788.

A study of 29 cases of Hodgkin's disease revealed pulmonary involvement in nine, an incidence of 31 per cent. One hundred and twenty-five cases collected from the literature, representing eight authors (including the present authors' 29), showed pulmonary involvement in 47, an incidence of 37.6 per cent.

In describing the pulmonary findings the authors present them from the clinical, roentgenologic, and pathologic standpoints.

Seven cases are reported in detail.

Henry K. Taylor, M.D.

The "Gordon Test" for Hodgkin's Disease. Jacob D. Goldstein. Am. Jour. Med. Sci., June, 1936, **191,** 775–780.

The author describes the "Gordon Test"—encephalitic syndrome in rabbits following the intracerebral injection of suspensions of lymph glands obtained from patients with Hodgkin's disease.

Goldstein studied the rabbit reactions in 29 cases. Of these, nine were histologically proven cases of Hodgkin's. The other 20 were suspected of having Hodgkin's clinically but were proven to be the following: tuberculosis (5); chronic lymphadenitis (6), of

these two were infectious mononucleosis; leukemia (2); hyperplastic node (4); lymphosarcoma (3).

Of the nine proven cases of Hodgkin's disease, the Gordon test was positive in seven and negative in two. The Gordon test was negative in the 20 control cases.

HENRY K. TAYLOR, M.D.

Hodgkin's Disease of Bone. M. C. Morrison. Canadian Med. Assn. Jour., April, 1936, **34**, 393–396.

The author states that the term "Hodgkin's group" represents an undifferentiated group of atypical cases which seem to be gradations between lymphadenoma, leukemia, and lymphosarcoma. These produce three kinds of reaction, the inflammatory, the hyperplastic, and the tumor type, the latter differing from the others in its infiltrative and destructive behavior toward the surrounding tissues, its systemic spread, and the longer course of the disease. Characteristic roentgen changes are mottling, then focal necrosis, erosion of the cortex, gross thickening and lifting of the periosteum in rib and sternal involvement, and (rarely) osteoplastic changes in the chronic disease. In the vertebræ, destruction and collapse are the rule, but the disc cartilage remains intact. Metastatic carcinomas of the osteolytic types, Ewing's tumor, leukemia, and syphilis must be ruled out clinically to confirm the x-ray diagnosis of Hodgkin's disease.

W. H. GILLENTINE, M.D.

INFECTIONS (THERAPY)

An Analysis of the So-called Bactericidal Effect of Roentgen Rays in Local Infections and in Inflammatory Processes. A. O. Nathanson. Strahlentherapie, 1936, **55**, 521.

The author studied the mechanism of the beneficial effect of small and moderate doses of roentgen rays in inflammatory diseases. The experiments were conducted on the inguinal glands of rats with paratyphoid bacillus B. Roentgen rays have no direct bactericidal effect, neither *in vitro* nor *in vivo*, if used in the customary therapeutic doses. The effect of the rays in inflammatory diseases cannot be explained, therefore, by their bactericidal properties but by a change of the tissue reaction to bacteria following irradiation. The bactericidal power of blood and tissue was not found increased after irradiation.

ERNST A. POHLE, M.D., Ph.D.

Roentgen Therapy of Certain Infections. Fred M. Hodges. Am. Jour. Roentgenol. and Rad. Ther., February, 1936, **35**, 145–155.

This subject, in this country, is not receiving from many radiologists the attention it deserves. In this article only those conditions in which x-radiation has definitely proven to be the best method are considered.

Erysipelas.—Irradiation is practically a specific when the lesion is local. Small early lesions nearly always disappear within twenty-four hours after the treatment. Large infected areas usually show an early localization, with gradual cure within a few days. In some, there is a marked walling off or pointing of the infection, with the formation of a small central mass which can be lanced. Best results are obtained with 85 kv., 125 r; no filter. This dose is repeated if necessary.

Furunculosis.—Owing to the fact that the infection is often deep, the best prescription is 125 kv., 125 r, 4–6 mm. aluminum filter, at weekly intervals for several treatments. The existing lesions are cured and new ones aborted.

Carbuncle.—Irradiation certainly in the large majority limits the spread, lessens the pain, increases drainage, shortens the duration of the disease somewhat, and definitely lowers the mortality. The prescription is 85 kv., 100 r, no filter, for two or three doses. In very early lesions, a large filtered dose may abort the condition. There must be close co-operation with the medical man to treat the general condition if necessary.

Infected Rhinophyma.—The prescription is 125 kv., 300 r, 4–6 mm. Al filter. Several of these conditions were cured by the author.

Infected Angioma.—A large dose is necessary but the condition is radiosensitive and excellent results can be obtained.

Granuloma.—In the ordinary type consisting of very cellular and richly vascular granulations with associated infection, 700 to 900 r, unfiltered, at 85 kv., has given excellent results. In telangiectatic granuloma, one to three doses of low voltage, unfiltered, have invariably produced good results.

Blastomycosis.—In some of the serious fungus infections, especially in cases in which the lesions are limited, 500 to 600 r, 125 kv., 4–6 mm. Al filter, 10-in. distance, has given excellent results. Iodine therapy should be given along with the radiation.

Parotitis.—Many acute, subacute, and chronic cases have almost uniformly responded well with from three to five doses of 125 kv., 125 r, 4–6 mm. Al filter, and 10-in. distance.

Mikulicz's Disease.—Five cases have responded to 200 kv., 100 to 400 r, 1 mm. copper, 1 mm. Al filter at 50-cm. distance. In several, the dose was repeated after four weeks. Mikulicz's syndrome will also respond temporarily to irradiation. The final outcome is, of course, dependent upon the particular disease with which it is associated.

Localized Infections, Especially on and about the Face.—Irradiation in these conditions reaches probably its greatest usefulness in preventing spread to the vessels of the brain or general septicemia. In the slightest spread of the infection to the surrounding fixed tissues, 100 to 150 r, unfiltered, low voltage, is applied. As a rule, rapid walling off occurs within from 6 to 12 hours. If definite improvement within 24 hours has not occurred, consultation with a bacteriologist and immunologist is indicated, and suitable other methods of treatment should be instituted, such as the administration of antistreptococcic or other serum.

The value of irradiation on these and other infections has been definitely shown to be due to the liberation of

some substance present in the leukocytes which are destroyed by the irradiation. Thus, in cases in which leukocytic infiltration is slight the irradiation result is not so good. Radiologists have a definite duty to perform, namely, to acquaint the medical men with the value of irradiation in these conditions.

S. M. ATKINS, M.D.

THE KIDNEYS

Traumatism of the Kidney. W. Calhoun Stirling. British Jour. Urol., March, 1936, **8,** 1–20.

Injuries of the renal parenchyma are more common than those involving the pelvis, and represent the average case with mild hematuria; these may heal spontaneously, many of which, however, will later become functionless. The kidney is the most frequently ruptured abdominal viscus and has the best prognosis.

Conservative treatment with supportive measures and a long rest in bed will cure the majority of mild lacerations of the kidney, with the exception of those involving the pelvis; the latter usually require incision, repair, and drainage. Nephrectomy is reserved for severely injured kidneys with torn renal vessels and fragmentation of the major portion of the kidney.

Intravenous urography offers a simple, safe method of determining the degree and site of laceration of the kidney, and may be combined with a retrograde urogram if the renal shadow is absent. Individualization of cases is essential as a guide to proper management of renal injuries.

DAVIS H. PARDOLL, M.D.

The Kidney Pelvis: Its Normal and Pathological Physiology. J. Leon Jona. Proc. Roy. Soc. Med., April, 1936, **29,** 623–628.

The author describes his technic and method of study: retrograde urography, including fluoroscopy.

He likens the pelvis and calyces to a series of muscular chambers contracting in regular sequence, and separated or connected by muscular valves or sphincters. Because of the muscle tone in the ureter, pelvis, and calyces, there is always some urine in the pelvis and calyces—about 8 c.c., the maintenance filling.

The author describes various types of dysfunction affecting the pelvis and ureter. He also describes another method of investigation whereby a graphic record of the contractions of the kidney pelvis is obtained—pyelometry, with the aid of a recording tambour attached to an inlying (No. 7 or No. 8 Charrière) catheter.

HENRY K. TAYLOR, M.D.

Ectopic Pelvic Kidney. Gilbert J. Thomas and J. C. Barton. Jour. Am. Med. Assn., Jan. 18, 1936, **106,** 197–199.

An ectopic kidney is one which is congenitally displaced and has never occupied a normal position. An ectopic pelvic kidney is one fixed within the bony pelvis or across the spine and derives its blood supply from the adjoining large vessels, such as the iliac arteries.

Reviewing the embryology of the kidney reveals that ectopic pelvic kidney is a defect of development that occurs before the eighth week. The incidence of congenital ectopic kidney is one in 882 autopsies and one in 547 urologic examinations.

The condition may be symptomless and the diagnosis may require cystoscopy, ureteral catheterization, and bilateral pyelo-ureterograms, either by the retrograde or the excretion method. It must be considered when pelvic tumors are found in either sex, and in the female when abortions occur or when normal pregnancies are interfered with by some abdominal or pelvic mass.

Treatment consists of nephrectomy if symptoms are produced, provided the contralateral kidney is normal.

CHARLES G. SUTHERLAND, M.B. (Tor.).

The Cause for Extravasation of the Kidney Pelvis and Its Prevention. Paul Eichler. Röntgenpraxis, December, 1935, **7,** 803–806.

Extravasation of the kidney pelvis is defined as any abnormal finding of contrast material outside of the pelvis; for instance, a subcapsular filling, injection of a tubulus, or a pyelovenous reflux. All these not in common findings are due to the technical procedure and not to a pathologic cause. The author has found evidence of extravasation in about 1 per cent of his pyelograms. In another series of cases it happened in 6.8 per cent of the pyelograms. Symptoms due to it were very slight, if any at all. The author warns against colloidal or oily contrast materials. He believes that these accidents may be avoided by careful technic, except in a very few cases in which a spasm of the pelvis and calyces might produce extravasation.

HANS W. HEFKE, M.D.

THE LUNGS

Cystic Disease of the Lung. Herman Hennell. Arch. Int. Med., 1936, **57,** 1–17.

The author presents eight cases and discusses the clinical features, the diagnosis, the therapeutic problems, and the mechanism of the symptoms and signs of the condition.

Case I. Male, aged 46 years. Several oval and round air cysts were present in both lower lobes. One large cyst was filled with fluid.

Case II. Female, aged 23 years. Pneumothorax was present near the apex of the lung, with numerous air cysts below the pneumothorax. The heart and mediastinum were displaced to the opposite side. This case was classed as congenital.

Case III. Male, aged 46 years. Diffuse fibrotic process involved both lungs, with thickening of the pleura and diaphragmatic adhesions. Postmortem examination revealed extensive cystic disease and there was a firm mass which proved to be a large blood clot.

Case IV. Male, aged 65 years. Small shadows were scattered throughout both lungs, suggestive either of "healed" miliary tuberculosis or of pulmonary vascular disease with fibrosis. In one of the lower lobes there was a large bullous cyst adjacent to an area of fibrosis.

Case V. Male, aged 60 years. A large air cyst was found in the apical portion of the lung adjacent to an area of fibrosis. The bronchi in the upper lobe appeared to be distorted. This patient had an associated polycythemia. It is conceivable that these two conditions may be etiologically related.

Case VI. Male, aged 45 years. A bullous emphysema existed in the lateral portions of the lower lobe. In addition, there was evidence of a chronic pneumonic process as well as of diaphragmatic and pleuropericardial adhesions at the base of the lung. The diagnosis was confirmed by injection of iodized poppy-seed oil through the chest wall under fluoroscopic control. Associated bronchiectasis was diagnosed by the iodized oil studies.

Case VII. Male, aged 53 years. A roentgenogram showed bronchiectatic air cysts along the border of the heart partially outlined by the iodized oil. The small cavity adjacent to the heart was shown at operation to be an infected air cyst.

Case VIII. Male, aged 22 years. A roentgenogram showed marked shrinkage of one lung, with numerous cavities varying greatly in size. Postmortem examination showed cysts of the bronchiectatic variety.

E. M. SHEBESTA, M.D.

A Study of the Lower Lobe of the Lung: An Explanation of Roentgenologic Shadows. Joseph Levitin and Harold Brunn. Arch. Int. Med., April, 1936, **57,** 649–665.

These studies indicate that the lower lobe of both the right and left lung is divided into two parts, an anatomical fact which has been insufficiently emphasized. The division of the lower lobe can be proved anatomically, embryologically, and by a study of the bronchial distribution to the lower lobe. At times, a fourth lobe on the right side and a third lobe on the left side may be present as an anomaly when fusion between the two divisions of the lower lobe has failed to take place. Each of the two divisions may be, and often is, separately involved by a disease process, and each gives different shadows on the roentgenogram. In the lateral projection the superior division is well seen on the roentgenogram as a triangular area posteriorly placed, with the apex at the hilus. The upper border of this division corresponds to the interlobar septum between the upper and lower lobes. The lower border corresponds to an imaginary line drawn from the hilus backward and downward to the eighth rib posteriorly. The second, or inferior, division of the lower lobe is the major division and takes up the remaining portion of the area occupied by the lobe.

Two distinct bronchial distributions are always present in the two divisions of the lobe, a fact which was established by a study of roentgenograms of postmortem specimens, with the bronchi of the lower lobe filled with 30 per cent bismuth subnitrate in petrolatum. The first branch from the main bronchus to the lower lobe of the right lung arises opposite the bronchus of the middle lobe. This branch is directed posteriorly and soon divides into smaller branches. In the left lung the bronchus to the superior division occupies a comparable position. An interlobar fissure may be observed to separate the divisions partially or completely.

Diagrams of embryologic specimens are shown to illustrate a separate anlage for the two divisions.

The superior division is the one more frequently involved in pneumonic processes. The bronchi to this division are directed posteriorly and when the patient is in the prone position, the action of gravity on secretions may be of some significance. Pneumonic involvement in this region is sometimes interpreted as evidence of central pneumonia.

Several illustrative case reports are presented.

E. M. SHEBESTA, M.D.

The Roentgen Image of the Lungs in Bronchial Asthma. J. G. Dillon and J. B. Gurewitsch. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1936, **53,** 66–73.

A series of 147 patients with so-called bronchial asthma was reviewed, 76 men, 71 women, all under 40 years of age, and the following conclusions were drawn:

(1) There is no characteristic roentgen appearance of bronchial asthma.

(2) Pulmonary tuberculosis is no more frequent in the presence of bronchial asthma than in non-asthmatics.

(3) Many patients with bronchial asthma show signs of pulmonary emphysema. This is the more frequent the longer the duration of the asthma. It is, therefore, assumed that emphysema occurs because of the asthma but not as the etiology of the asthma.

(4) Enlargement of tracheobronchial and hilar lymph nodes, pleuritic and bronchitic changes are no more frequent in cases of asthma than in non-asthmatics.

(It is to be regretted that no reference is made in this paper to infection of the upper air passages, especially the paranasal sinuses, to bronchospasm and allergy.)

H. A. JARRE, M.D.

The Substrate of Marginal Shadows along the Lateral Curvature of the Middle and Lower Ribs (Lamellar Pleurisy). A. Kubat and W. Neugebauer. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1936, **53,** 53–66.

The first part is devoted to roentgen anatomic investigations concerning these marginal shadows.

The second part concerns an anatomic study concerning the occurrence of fat pads in the normal parietal pleura.

Small marginal shadows on the inner border of the lateral thoracic wall are not always of pathognomonic significance but in many cases are cast by normal soft tissue structures. Frequently they are produced by

well-formed fat deposits on the parietal pleura. The inner muscle-layers along the course of the ribs, described by Knutsson, usually do not become apparent in straight sagittal chest views. The marginal shadows mentioned are not to be regarded as a pure optic deception; the tangential projection of parietal and visceral pleura at times is sufficient to produce such shadows.

In the anatomic part of this paper several specimens are reproduced showing the fat pads mentioned. It is pointed out in these papers that "lamellar pleurisy" as reported first by Fleischner, in 1927, does occur and may produce quite similar appearance of the marginal portions of the chest.

H. A. JARRE, M.D.

PNEUMOTHORAX

Paradoxical Opacities within a Pneumothorax. F. Fleischner. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1936, **53,** 45–53.

So-called paradoxical opacities occurring usually in the peripheral portions of the pneumothorax are shown to result from broad pleural adhesions, commonly seen along the dorsal surface of the lower lobe, more rarely of the upper lobe. The production of this roentgenologic image is illustrated graphically.

Such paradoxical opacities offer nothing strikingly new to anyone who has any appreciable experience with pneumothorax therapy.

H. A. JARRE, M.D.

RADIATION SICKNESS

Nembutal in the Treatment of Radiation Sickness. G. E. Richards and M. V. Peters. Am. Jour. Roentgenol. and Rad. Ther., April, 1936, **35,** 522–525.

Forty cases of radiation sickness were treated with nembutal. The presence of liver disease is said to contra-indicate the use of this drug and perhaps 1 or 2 per cent of persons do not tolerate barbiturates; however, these are rare exceptions. The dose is 1.5 to 3 grains, given preferably one hour before the treatment. In a few cases which appeared to become resistant to the drug, even in 3 gr. doses, the addition of hydrochloric acid in 5-drop doses before meals, accomplished further control of upsets. The drug cannot be considered specific for radiation sickness, but it constitutes a great boon to the individual who might otherwise refuse to complete the series as planned.

J. E. HABBE, M.D.

RADIUM

Advantages and Disadvantages of the Radium Element Pack. James J. Duffy. Am. Jour. Roentgenol. and Rad. Ther., April, 1936, **35,** 508–512.

There is no five-year-result basis on which to judge radium pack efficiency. The early cases are subsequently treated by interstitial irradiation or surgery or both while the late cases present too many intangibles.

The filter of the pack at Memorial Hospital is of platinum and brass equivalent to 2 mm. of lead. The effective wave length corresponds to that of highly filtered x-rays produced at 1,500,000 volts. Because of low intensity the duration of treatment must be relatively long both in time per treatment and in number of treatments. It is customary to give exposures of two hours per day. At 6 cm., three days are required to give 24,000 mg.-hr. or six days if treatment included both sides of the neck; at 15 cm., thirty days of treatment are required.

Comparing 200 kv. radiation filtered through 0.5 mm. copper at 50 cm. distance, 540 r was found to produce the same skin reaction as 190 minutes exposure to the radium element at 6 centimeters. The r output measured by skin effect was 2.8 r at 6 cm., 1.2 r at 10 cm., and 0.57 r at 15 centimeters. However, by the usual small ionization chamber measurement the r output from the radium pack was three to four times as much as estimated by skin effect. If this is due to a difference of skin effect caused by shorter wave length, then the skin may be given three to four times as much radium pack radiation as 200 kv. radiation, which factor more than offsets the better depth doses obtained by 200 kv. radiation at 50 cm. as compared to the radium pack at 6 or 10 centimeters. At the present time the longest practical radium pack-skin distance is 15 cm.

From a mechanical point of view the radium pack, because of its bulkiness and heaviness, is difficult to apply to the neck, axilla in stout patients, and the perineum. The time factor is also in some measure unfavorable, since a two- or two-and-a-half-hour treatment time is difficult for some patients to tolerate.

Despite these mechanical disadvantages of the radium pack, and the lack of statistical results, the author is of the opinion that the clinical results in some cases of pharyngeal, laryngeal, breast, and rectal tumors, and in Hodgkin's is better with the packs than with 200 kv. x-rays.

J. E. HABBE, M.D.

SILICOSIS

The Diagnosis of Silicosis, with Special Reference to Roentgenological Manifestations. Leroy U. Gardner. Ann. Int. Med., August, 1936, **10,** 166–173.

The author's summary is as follows:

Regardless of the history of exposure to dust, a diagnosis of silicosis should not be made until generalized discrete nodular shadows are visible in the lung-fields. Large localized shadows suggest complicating infection but there is a conglomerate type of simple silicosis that occurs in the absence of active infection. It may result from pulmonary damage by previous infection that has healed. It can be differentiated from active infection only by careful clinical study and by repeated roentgenograms to exclude change in the character and size of the lesion. The silicotic lung may exhibit the usual manifestations of turberculosis, superimposed upon a background of generalized nodu-

lation; more common are the massive foci of consolidation due to silico-tuberculosis. These may be situated in the upper parts of the lung where they result from reactivated apical foci of tuberculosis but frequently they occur in the mid or lower lung. They consist of a very chronic combination of tuberculosis and silicosis progressing simultaneously in the same area. They give rise to much less pronounced symptoms of intoxication than tuberculosis alone. More acute forms of tuberculosis, aspiration disease, and miliary tuberculosis occur but they are not very common.

Non-silicous dusts are generally responsible for an exaggeration of the linear markings of the lung. As far as known, the slight perilymphatic reactions responsible for them do not interfere with pulmonary function and they do not alter the native susceptibility to tuberculosis.

Asbestosis is not so well understood. The roentgenogram shows a diffuse haziness of the lower lung-fields and later a very fine uniform stippling. Whether chronic pleurisy, increased linear markings and conglomerate shadows are due to the dust, to secondary changes incident to collapse of lobules, or to complicating infection, has not been definitely settled. The appearance of a tuberculous lesion in the asbestosis-infiltrated lung is apparently not modified. There may be some tendency toward chronicity.

HANS A. JARRE, M.D.

SOFT TISSUE ROENTGENOGRAPHY

Soft Tissue Roentgenography: Anatomical, Technical, and Pathological Considerations. John R. Carty. Am. Jour. Roentgenol. and Rad. Ther., April, 1936, **35,** 474–484.

By proper technic the following tissue layers may be identified on an x-ray film: skin, "subcutaneous dark zone," subcutaneous reticulated zone (panniculus adiposus), fascia, muscle layer, bone. In some instances, particularly at the flexures of extremities, one may identify blood vessels and nerves. If air is injected into the facial spaces and a film made, the author designates it a fasciagram. Muscle detail is better in children and the aged; in the athletic young adult this tissue layer is more amorphous. Enlarged glands may in certain regions, particularly the supraclavicular spaces, be demonstrated which have escaped clinical detection. The uterus and bladder may often be outlined.

Fatty or mucous tumors may be less dense than soft tissue tumors of other composition. Hemangiomas are the only soft tissue tumors the nature of which can usually be determined: these show worm-like structures of increased density due to the blood channels comprising them.

The technic recommended is 100 ma. for two or three seconds, 36 inch distance, and variable voltage (30–70). Films must be developed by sight.

J. E. HABBE, M.D.

TUBERCULOSIS, PULMONARY

Pulmonary Tuberculosis of the Lower Lobe. David Reisner. Arch. Int. Med., 1935, **56,** 258.

Tuberculosis of the lower lobe has been considered very rare due to the fact that one frequently fails to make a distinction between lesions of the lower lobe and basal lesions, and that these designations are often used promiscuously. Lesions confined to the superior portion of the lower lobe present neither clinical nor roentgenologic features indicative of a basal process and are in many instances responsible for the somewhat vague term "hilus tuberculosis." Oblique and lateral studies of the chest are urged, to assist in accurate localization of the lesions.

Occasionally the lower lobe appears to be markedly diminished in size. This may occur in the chronic case with cirrhotic contraction or in cases with lobar atelectasis following aspiration of blood.

The majority of patients show only a limited area of involvement, usually in the apical or subapical portion of the lower lobe. Cavitation occurs relatively early in these cases. In the lateral projection one notes that the involvement is usually near the dorsal wall. Another interesting and important finding is a sharp demarcation of the superior margin of the lower lobe which is best demonstrated in the lateral or oblique view. The cavities are frequently large and thin-walled and consequently are often mistaken for non-tuberculous abscesses. An interlobar fissure line extending across the annular shadow is practically a conclusive sign that the cavity is situated posteriorly, within the apex of the lower lobe.

In most cases there is a bronchogenous spread into other portions of the lung and not infrequently spreading to the apex of the upper lobe. The author is convinced that there is little, if any, anatomic or pathologic relationship with the hilar structure in this form of tuberculosis.

Tuberculosis of the lower lobe occurs principally in women and is very uncommon in men. The author explains this on the basis of existing physiologic variations in the respiratory mechanism.

Collapse therapy is the only effective treatment and artificial pneumothorax is the procedure of choice, despite the location in the lower lobe.

Cystic disease of the lung has to be differentiated from pulmonary tuberculosis, benign bronchial bleeding, bronchial neoplasm, bronchiectasis, tension pneumothorax, foreign body, obstructive emphysema, and putrid pulmonary abscess. The chief complaints included recurring hemoptysis, episodes of pain in the chest and dyspnea, productive cough, and foul expectoration.

The following pneumodynamic mechanisms were analyzed: (1) the development of an air cyst, as determined by aplasia or destruction of the surrounding pulmonary parenchyma, with resultant loss of elastic support; (2) the persistence or spontaneous disappearance of a cyst, as determined by the patency of its bronchial communication; (3) the growth and possible rupture of an air cyst, as determined by a check-valve type of

bronchial communication, with a resultant progressive increase in the intracystic pressure; (4) the mechanism of chronic pneumothorax and its relation to recurring cystic rupture; (5) the mechanism of mediastinal displacement and bronchial distortion as produced by large cysts with a high intracystic pressure, and (6) the cause of recurring pain in the chest and dyspnea as related to the rupture of air cysts, with resulting tension pneumothorax.

The therapeutic measures employed included artificial pneumothorax, extirpation of the cysts and the injection of iodized poppy-seed oil or similar substances into the cystic cavity.

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TUMORS (THERAPY)

The Place of Radiation in the Treatment of Cerebellar Medulloblastomas: Report of 20 Cases. Elliott C. Cutler, Merrill C. Sosman, and Walter W. Vaughan. Am. Jour. Roentgenol. and Rad. Ther., April, 1936, **35**, 429-453.

Cerebellar medulloblastomas occur by far the most commonly in early childhood, the peak being in the age-group of five to ten years. They are an uncommon form of tumor, forming as they do less than 1 per cent of all intracranial tumors (8.4 per cent of 862 verified gliomas in Cushing's reported series). Pathologically they are soft, vascular, and invasive and they may also be transplanted along the cerebrospinal pathways, being most commonly "seeded" by gravity. The location most often met with is in the midline, directly in the fourth ventricle. They do not metastasize outside the central nervous system. Histologically, they are highly cellular and vascular, the typical cell being a small round or oval one with scanty cytoplasm. Clinically the case is usually that of a preadolescent child (males being affected three times as often as females), who complains of headaches or suboccipital discomfort, occasional morning vomiting without nausea, and awkwardness of gait. The head may enlarge unduly fast, and vision is apt to be impaired. In adults, headache and vomiting are apt to be minor symptoms, tinnitus and deafness being more common.

The course of the lesion is rapidly fatal, death usually occurring within twelve months after onset except for operative intervention or roentgen therapy.

It is important that roentgenologists be familiar with these tumors since radiation therapy plays such an essential part in the control of the case. It is imperative, however, that there be close co-operation between radiologist and neurosurgeon, since dehydration must be carried out prior to radiation and at times surgical intervention is necessary to control reactions of the patient.

The writers are of the opinion that under proper clinical control and preliminary dehydration therapy, x-ray therapy may accomplish as long palliation as surgical removal, and be attended with practically no mortality, in contrast to the 24 per cent operative mortality in the hands of the best neurosurgeons. These lesions may well be looked upon as the lymphomas of the central nervous system, at least insofar as their radiosensitivity is concerned. It is this rapid response of most of these tumors to limited amounts of radiation which justifies attempting to control the case without surgery and biopsy: in the authors' experience the test of ten days of radiation will confirm the clinical diagnosis of this pathological type of tumor by the marked clinical improvement.

The technic used is as follows: 185 kvp.; 4 ma.; 0.5 mm. copper plus 1.0 mm. aluminum filter; target-skin distance 40 cm.; 10.8 r per minute; effective wave length 0.157 Angström; cerebellar portal 10 cm. × 10 cm., lateral ventricles (right and left) 15 cm. × 15 cm., spine (cervicothoracic and thoraco-lumbar) 12 cm. × 30 cm.; maximum daily dose 300 r; maximum field dose 600, except cerebellum, which receives 800 r at 200 r daily. Ordinarily it is only the radiation to the cerebellum which must be given with particular care to avoid blocking the aqueduct by edema. After six weeks the cerebellar treatment only is repeated; two months later the entire series (head and spine) is repeated; three months later the cerebellum only is treated; after three months and again after six months the entire series is repeated.

Two cases which have had only radiation without surgery are alive and well, one having been symptom-free for thirty-five months.

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